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SAILOR'S SEA-BOOK.

JAMES CALBRAITH

AND

W. H. DOSSER

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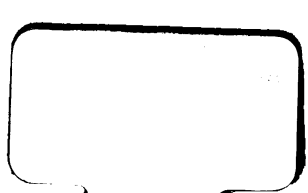

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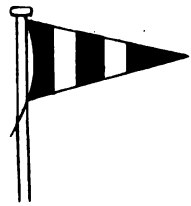

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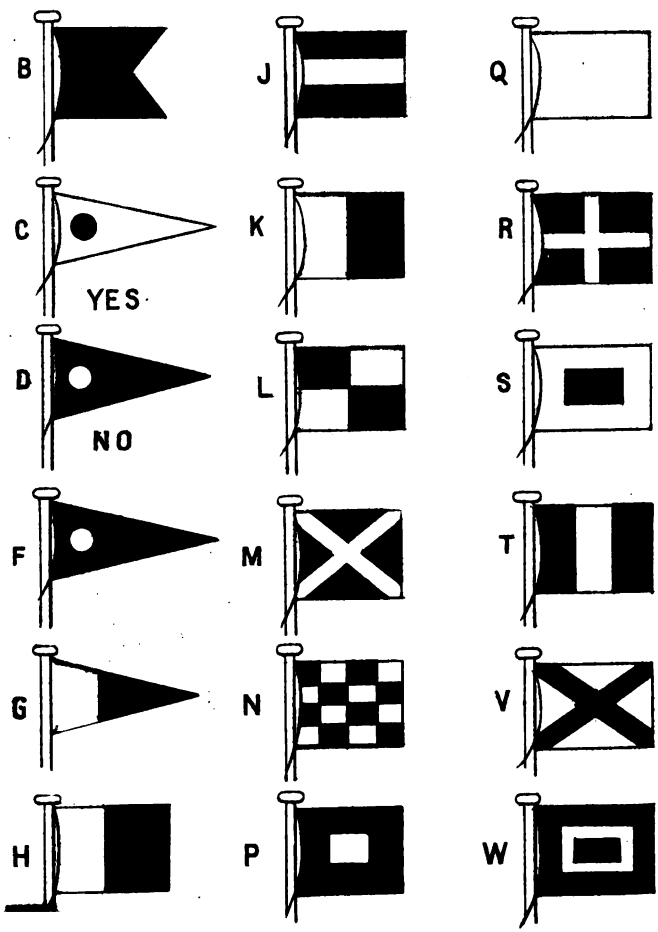

THE SAILOR'S SEA-BOOK

A

RUDIMENTARY TREATISE

ON

NAVIGATION

PART I.—HOW TO KEEP THE LOG AND WORK IT OFF
PART II.—ON FINDING THE LATITUDE AND LONGITUDE

BY JAMES GREENWOOD, B.A.
OF JESUS COLLEGE, CAMBRIDGE

TO WHICH ARE ADDED

THE DEVIATION AND ERROR OF THE COMPASS; GREAT CIRCLE SAILING; THE INTERNATIONAL (COMMERCIAL) CODE OF SIGNALS; THE RULE OF THE ROAD AT SEA; ROCKET AND MORTAR APPARATUS FOR SAVING LIFE; THE LAW OF STORMS; AND A BRIEF DICTIONARY OF SEA TERMS

WITH NUMEROUS WOODCUTS
AND COLOURED PLATES OF FLAGS

NEW, THOROUGHLY REVISED, AND MUCH ENLARGED EDITION

BY W. H. ROSSER
AUTHOR OF THE "DEVIATION OF THE COMPASS CONSIDERED PRACTICALLY," "THE YACHTSMAN'S HANDY-BOOK FOR SEA USE," ETC. ETC.

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PREFACE.

THE SAILOR'S SEA-BOOK was not written for the purpose of supplying any deficiency in works treating of the same subject. Its object was merely to assist a Yachtsman or Master who, with the intention of conducting his vessel safely to her destination, deemed it preferable to know a little of Navigation perfectly, than all its branches indifferently. This purpose, amidst many additions and alterations in the new edition, has never been lost sight of.

The Navigation is divided into two parts :—

I. How to keep the Log and work it off;—in other words, to keep the Dead Reckoning.

II. To find the Ship's Place by Observation, that is, the Latitude by a Meridian Altitude of the Sun, and the Longitude by Chronometer and Sun's Altitude; together with the Deviation and Error of the Compass.

Too much space was formerly given to the method by projection, a mode of working out problems in Navigation never adopted by the practical seaman, who uses the Traverse Tables and Logarithms, together with a few other short tables of easy reference. By the aid of the Traverse Tables he gets his position by Dead Reckoning: by the aid of the other Tables and the *Nautical Almanac*—when he knows how to use the Sextant and Chronometer—he finds his position from Observation. If he is a careful navigator he al-

ascertains the Error of the Compass. All these problems are now treated with as much brevity and precision as possible, so that a great fund of information will be found in a very limited space. Indeed there is as much of practical Navigation in this Rudimentary Treatise as would enable a Yachtsman to take a vessel round the world.

The endeavour throughout has been to make the subject plain, easy, and practical.

To this edition has been added a full account of the *International* (*Commercial*) *Code of Signals*, and its use under the varied forms of Flags, Distance Signals, and the Semaphore, &c. Nor have *Rule of the Road at Sea* and the *Rocket and Mortar Apparatus for Saving Life* been forgotten.

The short essay on *The Law of Storms* is by Mr. CHARLES TOMLINSON, who has brought together the most important facts connected with that subject, and it met with the full approval of Colonel Sir WILLIAM REID, K.C.B., who said:—"Mr. Tomlinson must have studied the storm subject with great attention, to have been able to make so good an outline of it." It has received a few additions in the form of a summary of recent investigations, together with the leading rules for manœuvring a ship when overtaken by a hurricane.

The work closes with a *Dictionary of Sea Terms*, chiefly from Dana's "Seaman's Friend," which will be acceptable to beginners.

W. H. ROSSER.

Note to the Student.—You will require Law's and Young's *Mathematical and Nautical Tables* (No. 201, in the "Rudimentary Series") for the solution of the problems, as well as for daily sea-use; and you will find that a selection from the *Nautical Almanac* for 1882 has been inserted in its place to assist you.

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REQUISITE ELEMENTS
FROM THE NAUTICAL ALMANAC, 1882,

FOR THE EXAMPLES IN THE RUDIMENTARY TREATISE ON NAVIGATION.

Signs + (add) and − (subtract) to left of Equation of Time indicate application to *Apparent Time.*

APPARENT NOON. Page I.			MEAN NOON. Page II.			
Date.	Sun's Declination.	Var. in 1 hour.	Sun's Declination.	Sun's Semid.	Equation of Time.	Var. in 1 hour.
1882.	° ′ ″	″	° ′ ″	′ ″	m. s.	s.
Jan. 19	S. 20 17 28·7	31·80	S. 20 17 34·6	16 17	+11 1·96	0·759
20	20 4 34·1	32·74	20 4 40·3	16 17	11 19·81	0·728
21	19 51 17·0	33·67	19 51 23·5	16 17	11 36·90	0·695
Mar. 19	0 28 35·0	59·27	0 28 42·8	16 5	7 51·92	0·743
20	S. 0 4 52·6	59·25	S. 0 5 0·1	16 5	7 34·02	0·749
21	N. 0 18 49·0	59·21	N. 0 18 41·8	16 5	7 15·98	0·754
April 14	9 28 17·8	53·92	9 28 17·6	15 58	+ 0 13·98	0·629
15	9 49 47·2	53·52	9 49 47·2	15 58	− 0 0·94	0·614
16	10 11 6·9	53·11	10 11 7·2	15 58	0 15·48	0·598
27	13 53 23·9	47·64	13 53 25·9	15 55	2 28·32	0·400
28	14 12 20·4	47·06	14 12 22·5	15 55	2 37·67	0·379
29	14 31 2·9	46·47	14 31 5·1	15 54	2 46·53	0·358
May 16	19 8 25·0	34·50	19 8 27·2	15 51	3 51·77	0·047
17	19 22 3·3	33·69	19 22 5·5	15 51	3 50·36	0·071
18	19 35 22·0	32·86	19 35 24·1	15 50	3 48·39	0·094
June 13	23 13 47·0	8·30	23 13 47·0	15 47	0 16·18	0·523
14	23 16 53·9	7·27	23 16 53·9	15 47	− 0 3·55	0·530
15	23 19 36·1	6·24	23 19 36·1	15 47	+ 0 9·24	0·535
Aug. 19	12 44 15·6	49·06	12 44 18·4	15 51	3 26·61	0·569
20	12 24 32·0	49·56	12 24 34·6	15 51	3 12·71	0·589
21	12 4 36·7	50·04	12 4 39·1	15 51	2 58·33	0·609
22	11 44 30·0	50·51	11 44 32·3	15 51	2 43·48	0·628
23	11 24 12·2	50·96	11 24 14·3	15 52	2 28·16	0·647
24	11 3 43·7	51·41	11 3 45·5	15 52	2 12·39	0·666
25	10 43 4·7	51·84	10 43 6·3	15 52	1 56·18	0·684
26	10 22 15·6	52·25	10 22 17·0	15 52	1 39·55	0·701
27	10 1 16·7	52·65	10 1 17·9	15 52	+ 1 22·52	0·718
Sept. 22	N. 0 15 20·7	58·44	N. 0 15 13·6	15 59	− 7 19·31	0·872
23	S. 0 8 2·3	58·47	S. 0 8 9·8	15 59	7 40·20	0·868
24	0 31 25·9	58·49	0 31 33·7	15 59	8 0·99	0·863
25	0 54 49·7	58·49	0 54 57·9	16 0	8 21·64	0·857
Oct. 19	10 2 54·7	54·19	10 3 8·3	16 6	14 57·68	0·444
20	10 24 30·9	53·81	10 24 44·4	16 6	15 8·04	0·419
21	S. 10 45 57·7	53·41	S. 10 46 11·3	16 7	−15 17·77	0·393

RUDIMENTARY NAVIGATION.

ROBERTSON, head-master of the Royal Academy at Portsmouth, in the last century, aptly described *Navigation* as "*the art of conducting a ship from one port to another;*" it is our purpose here to show how this is accomplished, and how a ship's position is determined day by day:—1, by keeping the log and working it off; and 2, by finding the latitude and longitude, from observations of the sun, taken by means of the quadrant or sextant, together with the use of the chronometer.

PART I.

HOW TO KEEP THE LOG AND WORK IT OFF.

THE ARITHMETIC OF NAVIGATION.

OUR first step must be to have a clear knowledge of those parts of arithmetic that constantly come into use in Navigation: they are, 1, the addition, subtraction, multiplication, and division of compound quantities; and 2, decimals. As you can make no progress unless you understand these, I will delay you a few minutes to explain the method of treating them.

In the *measurement of time* the day is used, reckoned through 24 hours without the distinction of A.M. and

P.M.; then, as in the ordinary way, every hour is divided into 60 minutes, and every minute into 60 seconds; the three denominations are marked thus ($^{h\ m\ s}$), and $18^h\ 40^m\ 21^s$ express 18 hours, 40 minutes, 21 seconds.

In the *measurement of space*, often called *angular measure*, degrees, minutes, and seconds are used; every degree is divided into 60 parts, called minutes; and every minute into 60 parts, called seconds; these three denominations are marked thus (° ′ ″), and 8° 43′ 17″ express 8 degrees, 43 minutes, 17 seconds.

Note.—The symbols of time and space should never be used the one for the other, since 1 hour is the equivalent of 15 degrees.

In the following examples of *addition* and *subtraction* of degrees, &c., and of hours, &c., it will be found that the principle is exactly similar to compound addition and subtraction of pounds, shillings, and pence:—

Ex. To	72°	54′	58″
add	4	47	51
Ans.	77	42	49

Ex.	39°	40′	17″
	51	56	0
	70	9	59
Ans.	161	46	16

Ex. To	14h.	10m.	49s.
add	2	48	19
Ans.	16	59	8

In the first example the sum of 58″ and 51″ equals 109″, which, on dividing by 60, make 1′ 49″; therefore, writing down 49″, we carry on 1′ to be added to the other minutes, which now amount to 102′; these, being also divided by 60, give 1° 42′; therefore, writing down 42′, we carry on 1° to be added to the other degrees, which now amount to 77°. The other examples are similarly treated.

We now proceed to subtraction.

Ex. From	44°	13′	18″	*Ex.* From	11h.	48m.	52s.
subtract	17	24	32	subtract	9	44	51
Ans.	26	48	46	*Ans.*	2	4	1

As before observed, this operation is similar in principle to common compound subtraction, commencing on the right hand, and when required, adding the components (60″ or 60′) of one of the next denomination to the number subtracted from; thus, when we have to subtract 32″ from 18″, we must add 60″ to the 18″; then 32″ subtracted from 78″ leave 46″; having thus *borrowed* 1′, we have to add it to the 24′, making now 25′ to be subtracted from 13′, when we again proceed in a similar manner.

It will frequently be necessary to subtract an upper line of figures from a lower, and often similarly to the following examples:—

Subtract	72°	45′	4″	Take	97°	56′		Take	184°	14′	
from	90			from	180			from	360		
Ans.	17	14	56	*Ans.*	82	4		*Ans.*	175	46	

In the first example we had to borrow consecutively 60″ and 60′.

We shall also have at times to *multiply* degrees, &c., and hours, &c., thus—

Multiply	8°	35′	46″
by			4
Ans.	34	23	4

Here 46″ multiplied by 4 equal 184″, which, when divided by 60, equal 3′ 4″; we put down 4″, and carry 3′ to the product of 4 times 35, which gives us 143′;

these equal 2° 23′; we put down the 23′, and carry 2° to the product of 4 times 8, which gives 34°.

But of this we shall have more to say farther on, when we show the relation of space to time.

We next take *decimals*. As regard *addition* and *subtraction*, merely place the decimal points immediately one beneath the other, and proceed as with common figures.

Ex. What is the sum of 87·5, 3·9, 8·6, and 142·7 ?

87·5
3·9
8·6
142·7

Ans. 242·7

Ex. From 143·2 take 97·5.

143·2
97·5

Ans. 45·7

Ex. Add 15 to ·03.

15·00
·03

Ans. 15·03

Ex. Subtract ·45 from 1.

1·00
·45

Ans. 0·55

In the *multiplication* of decimals, multiply as in common figures, and then point off from the right as many decimals in the product as there are decimals in the multiplier and multiplicand.

Ex. Multiply 21·39 by 9.

21·39
9

Product 192·51

Ex. Multiply 0·576 by 8.

0·576
8

Product 4·608

Ex. Multiply 49·01 by 6·8.

49·01
6·8

39208
29406

Product 333·268

Ex. Multiply 0·709 by 6·8.

0·709
6·8

5672
4254

Product 4·8212

In the first example there are two figures of decimals in the multiplicand and none in the multiplier, therefore point off from the right two places of decimals in the product. In the last example there are three places of decimals in the multiplicand and one in the multiplier, together making four places, therefore point off from the right four places of decimals in the product.

In the *division* of decimals, when the dividend is greater than the divisor, affix as many ciphers as convenient.

Ex. Divide 24 by 60.

60) 24·0

0·4

Ex. Divide 46 by 60.

60) 46·00

0·76

ANGLES AND THEIR MEASUREMENT.

Our next step must be to obtain a clear notion of what an angle may be. It is the space contained by two

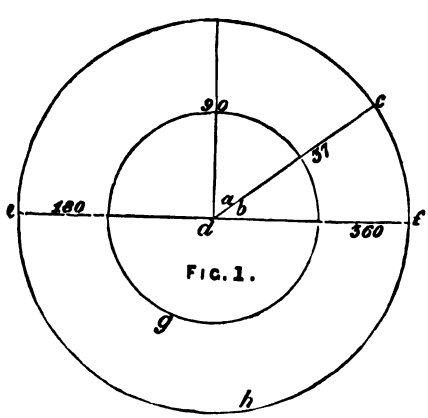


FIG. 1.

lines which meet each other, as the spaces *a* and *b* contained by the lines *c d* and *d e*, or *c d* and *d f* (fig. 1).

We hear of angles of 30 degrees, or 47 degrees, and so on. The method by which they are valued or reckoned is this. Every circle, of whatever size, is divided, by common agreement, into 360 divisions, called degrees. A semicircle, then, will contain half this number, or 180°. The fourth of a circle, or quadrant, will therefore contain 90°. An angle is measured by a certain number of degrees of the circle. It signifies not how small or large the circle may be, the angle remains the same, and the measure of it also, to whatever length the containing lines are produced, for the degrees subtending it are only enlarged or diminished in proportion to the circles, the smallest circle *g* containing the same number of degrees as the largest *h* (fig. 1).

The only *mathematical instruments required* are the protractor, parallel ruler, a pair of compasses with a pencil attached, a pair of common compasses (or *dividers*), and a pair of heavy parallel rulers about 18 inches or 2 feet in length.

THE PROTRACTOR.

In cases of instruments there is generally the brass semicircle for the protractor, but the flat ivory one with various scales on it is preferable. It is required in the *construction*, or projection of any mathematical figure, and as frequent reference will be made to it, I will here describe how to use it.

On one side of it, in the centre of its lower edge, is an isolated line or notch, thus (|). In measuring an angle this notch is to be placed at the point of the angle, and the edge of the protractor to be placed along one of the lines forming the angle; where the other line comes out from beneath the protractor will be denoted the number of degrees contained by the

angle. Should the lines be so short as to be concealed by the protractor, lengthen them until they extend from beneath it.

On the opposite side of the protractor is what is called the diagonal scale, with each extremity divided into a number of little squares; the left-hand scale being of half the proportions of the right-hand one, which latter we will now explain.

Let the spaces of the upper line represent one mile; then it will be seen that the upper line of the whole right-hand division of the rule represents ten miles. Proceeding towards the left are divisions marked 1, 2, 3, &c. Each of these is of the same size as the division containing the ten miles; so that should we wish to measure 36 miles, we put one point of the compasses on the division 3, and the other at 6, in the right-hand division. Again, should it be necessary, the spaces proposed to represent 10 miles may be adopted for 100 miles; each little square being tenths of these spaces, will now represent 10 miles, and the accuracy of this scale is as great, as it is simple and ingenious. Suppose it be required to take a distance to represent 268 miles,—put one point of the compasses at 6 on the upper line of the protractor, and trace the line down until you arrive opposite to 8 at the right-hand extremity of the protractor. Where the two lines cut each other let the point of the compasses rest, and stretch the other point, towards the left hand, along the parallel of 8 until it reaches 2. It need hardly be suggested that whether we assume the little squares to represent one mile or ten, whichever is adopted, the same scale must be preserved throughout the operation. When they are adopted as ten miles each, and we wish to measure off any number of miles, say 44, as before, put one point at 4, and trace it down until it comes to

the parallel of 4 on the right-hand extremity of the protractor, and then stretch the other point along the parallel to the perpendicular line of 0. Again, suppose we now wish to measure off fifteen miles,—place the compasses on the space representing 10, that is, on the line between 0 and 2, and follow it down until it comes to the parallel of 5, placed between 4 and 6, at the right end of the protractor; keeping the point where the lines cut each other, stretch the other point to the perpendicular line running from 0.

THE MARINER'S COMPASS.

A circular card (as shown on p. 9), divided into four quadrants by two diameters perpendicular the one to the other, has the two extremities of one diameter named respectively North and South, and the two extremities of the other named East and West, such that looking to the North, the East is to the right-hand and the West to the left. These *North, South, East, and West directions* are taken to *represent the cardinal points of the horizon.* Further, each of the quadrants just indicated is divided into 8 equi-angular spaces by lines radiating from the centre of the card, and since a quadrant contains 90°, each of these spaces represents an eighth of 90°, that is, $11\frac{1}{4}°$. Thus, the entire circle (of 4 quadrants) is divided into 32 equi-angular spaces, and these are the *points of the compass.* You will also see, by reference to the figure p. 9, that the divisions between any two of the cardinal points are exclusively named with reference to the two points between which they lie, thus those between North and East are indicated by various repetitions and transpositions of N. and E.; and so with the other divisions.

The card here described has affixed to its under side a small magnetised steel bar, or needle, such that its

length lies in the North and South line, while its North-seeking end is at the spot marked North on the card. The card, with its attached magnet, has only horizontal motion, and is mounted so as to rest on a steel pivot that rises from the centre of the bottom of a brass or copper bowl. The bowl has a glass cover, so that the indications of the card may the more readily be seen and read off; and to facilitate this a vertical

line is painted inside the bowl, to show in what direction the ship's head may be at any time.

The instrument described is the *Mariner's Compass*, which, by the aid of gimbals, is fitted into a wooden or brass binnacle, or perhaps into a skylight, wherever it can be best seen by the man at the wheel, or for taking bearings.

To *box the compass*, or, in other words, to name

the various points of it, must be acquired most accurately. Many persons imagine this to be so puzzling, that they give it up at once and for ever; but the whole business should be accomplished in about a quarter of an hour. To begin with, when once a quarter of the compass or circle is mastered, the rest is easily accomplished, for the same rule or arrangement applies to the other three quarters. I will now give two simple rules by which to learn the whole.

1. When the letters indicating two points are united, the point meant is half-way between the two; thus, N.E. is half-way between N. and E.; S.S.W. half-way between S. and S.W.

2. When the letters are joined by the word *by*, or the letter *b*, the point meant is the one which comes next after the first, going towards the second; thus, S. by W. is next to south, going west; N.E. *b* N. is next to N.E., going north.

Each of the points is also subdivided into half and quarter points; thus, N.W. $\frac{1}{4}$ W. is north-west and a quarter of a point more towards the west.

It is a common thing in connection with the calculations in Navigation to express the points of the compass numerically; thus, N. 3 pts. E. stands for N.E. *b* N., S. $4\frac{3}{4}$ pts. W. for S.W. $\frac{3}{4}$ W., and so forth. Similarly, it is often convenient to read the compass in degrees; thus, N. 53° E. means North 53 degrees towards East.

Now give special heed to what follows. The compass is taken to be the representation of the visible horizon, in the centre of which you stand on the deck of the vessel; consequently you must always look to your compass as if you were in its centre; otherwise you will misapply the terms right and left as applied to a course or bearing:—

Thus, one point to the right of N.E. is N.E. *b* E.; and one point to the left of N.E. is N.E. *b* N.

But, one point to the right of S.E. is S.E. *b* S.; and one point to the left of S.E. is S.E. *b* E., looking from the centre of the compass towards S.E.

The direction in which the ship is steered is the *compass course*, which requires to be corrected for leeway (if any is made), for variation, and for deviation, if an iron ship.

I append the *Names of the Points of the Compass, with their numerical and angular values.*

Names.		Points.	Angles.	Points.	Names.	
North	North	0	0° 0′	0	South	South
		¼	2 48¾	¼		
		½	5 37½	½		
		¾	8 26¼	¾		
N. *b* E.	N. *b* W.	1	11 15	1	S. *b* E.	S. *b* W.
		1¼	14 3¾	1¼		
		1½	16 52½	1½		
		1¾	19 41¼	1¾		
N.N.E.	N.N.W.	2	22 30	2	S.S.E.	S.S.W.
		2¼	25 18¾	2¼		
		2½	28 7½	2½		
		2¾	30 56¼	2¾		
N.E. *b* N.	N.W. *b* N.	3	33 45	3	S.E. *b* S.	S.W. *b* S.
		3¼	36 33¾	3¼		
		3½	39 22½	3½		
		3¾	42 11¼	3¾		
N.E.	N.W.	4	45 0	4	S.E.	S.W.
		4¼	47 48¾	4¼		
		4½	50 37½	4½		
		4¾	53 26¼	4¾		
N.E. *b* E.	N.W. *b* W.	5	56 15	5	S.E. *b* E.	S.W. *b* W.
		5¼	59 3¾	5¼		
		5½	61 52½	5½		
		5¾	64 41¼	5¾		
E.N.E.	W.N.W.	6	67 30	6	E.S.E.	W.S.W.
		6¼	70 18¾	6¼		
		6½	73 7½	6½		
		6¾	75 56¼	6¾		
E. *b* N.	W. *b* N.	7	78 45	7	E. *b* S.	W. *b* S.
		7¼	81 33¾	7¼		
		7½	84 22½	7½		
		7¾	87 11¼	7¾		
East	West	8	90 0	8	East	West

THE VARIATION OF THE COMPASS.

The *magnetic needle*, when unaffected by any surrounding iron, *points to* the *magnetic poles* of the earth, and the direction in which it trends at any place is called the magnetic meridian. As the magnetic poles are not coincident with the earth's true poles, which are the extremities of the axis of revolution, and between which the *true* meridians trend, it follows that the *magnetic meridian forms an angle with the true meridian, and this is the Variation* of the compass. In different parts of the world the variation differs, not only in amount, but also in direction; thus, over the North Atlantic, the greater part of the South Atlantic, and the Indian oceans, the variation is called Westerly, inasmuch as the North-marked end of the needle lies to westward of the true North, while over the Pacific Ocean it is called Easterly, because the North-marked end lies to eastward of the true North. In British waters the variation ranges between 19° W. in the Straits of Dover and 27° W. off the West Coast of Ireland and off the Hebrides.

You can understand that the two areas of easterly and westerly variation are separated by lines where there is no variation—*i.e.* where the magnetic needle shows true North and South; one such line trends through Eastern Europe, Asia, and Australia; another runs through North America, the east end of South America, and the S.W. corner of the South Atlantic. Everywhere the variation is constantly undergoing a gradual change in its direction; the annual change in our waters amounts to 8′.

In London and off the Isle of Wight, where the variation is 19½° W., the *true* North is indicated by the

compass direction which we call N. by E. $\frac{3}{4}$ E., or N. 19$\frac{1}{2}$° E. (in 1879).

All charts are engraved *true* North and South, East and West; but in various places the compass is engraved with its variation, which will easily be understood on inspection.

You must learn to convert *compass* courses and bearings into *true*, and the converse, and to do it with facility.

To correct compass courses and bearings for variation. RULE:—When the variation is *westerly*, apply it to the *left* of the compass indication; when *easterly*, apply it to the *right*.

Ex. Course by compass N.E., with variation 1$\frac{1}{4}$ points westerly, gives true course N.N.E. $\frac{1}{4}$ E., which is 1$\frac{1}{4}$ points to left of N.E.

Ex. Course by compass N., with variation 2$\frac{1}{4}$ points westerly, gives true course N.N.W. $\frac{1}{4}$ W.

Ex. Course by compass S. *b* W., with variation 2$\frac{1}{4}$ points westerly, gives true course S. *b* E. $\frac{1}{4}$ E.

Ex. Course by compass S.E. *b* E., with variation 2 points westerly, gives true course E. by S.

Ex. Bearing by compass W. $\frac{1}{2}$ N., with variation 1$\frac{1}{4}$ points westerly, gives true bearing W. *b* S. $\frac{1}{4}$ S.

Ex. Course by compass N. *b* W. $\frac{1}{2}$ W., with variation $\frac{3}{4}$ point easterly, gives true course N. $\frac{1}{4}$ W., which is $\frac{1}{4}$ point to right of N. *b* W. $\frac{1}{2}$ W.

Ex. Bearing by compass S.W. $\frac{1}{2}$ S., with variation 1$\frac{1}{2}$ points easterly, gives true bearing S.W. *b* W.

To reduce true courses and bearings to compass courses and bearings. RULE:—Apply *westerly* variation to the *right* of the true indication; *easterly* variation to the *left*.

Ex. True course W., with variation 2$\frac{1}{4}$ points westerly, gives compass course N.W. *b* W. $\frac{3}{4}$ W., which is 2$\frac{1}{4}$ points to right of W.

Ex. True course N. $\frac{1}{4}$ E., with variation 1$\frac{1}{4}$ points westerly, gives compass course N.N.E.

Ex. True course S.E. *b* S., with variation 2 points westerly, gives course to be steered S. *b* E.

Ex. True course S. ½ E., with variation 1¼ points westerly, gives compass course S. *b* W. ¼ W.

Ex. True course S.W., with variation ½ point easterly, gives compass course S.W. ½ S.

Ex. True course E., with variation 1½ points easterly, gives course to be steered E. *b* N. ½ N.

Ex. True course E., with variation 2¼ points westerly, gives course to be steered S.E. *b* E. ¾ E.

In British waters, to find the true course made good, apply the variation to the left of the point steered by compass; on the contrary, to find the magnetic or compass course to be steered, apply the variation to the right; because the Variation is Westerly.

DISTANCE AND THE NAUTICAL MILE.

The *distance* that a ship makes good is *reckoned* in *nautical miles*, and no other measure of distance is recognised in Navigation. This mile is the 21,600th part of the earth's circumference ($360° = 21{,}600'$), and is estimated to be about 6,087 feet, or 2,029 yards. It is roughly taken to be 1,000 fathoms, and hence a *cable's length* (which is the tenth part of a nautical mile) is 100 fathoms. A nautical mile = 1·1528 statute mile.

The knot is the equivalent of the nautical mile, and is the term generally in use in connection with a vessel's rate of sailing. When the rate is not determined by a Patent Log, the *log-line and sand-glass* are used: now, the length of a knot on this line must be in the same proportion to the nautical mile that the seconds of the glass are to the hour; 3,600 sec. = 1 hour, and take 6,000 feet = 1 mile; but as 3 to 5 is in the ratio of 3,600 to 6,000, hence, for the 14 seconds-glass the length of the knot will be 23·3 ft., being the result of $14 \times 5 \div 3$. This determination is the safe one of having the reckoning ahead of the ship.

LATITUDE AND LONGITUDE.

Latitude without longitude, or longitude without latitude, is of no use in fixing the position of a place on the land or at sea; both must be known for that purpose, and I must here offer a few words of explanation on the subject.

The *Latitude* of a place is its angular distance, *North* or *South*, from the equator, an imaginary circle round the globe, equidistant from the poles; and it is reckoned from 0° at the equator to 90° at the pole. We in the northern hemisphere are in N. Lat.

Now, you know we may sail either North or South. If, being in Lat. N., we sail N., we increase our latitude, or distance from the equator; but by sailing S. we decrease our latitude. And note that the northing or southing we make is called *difference of latitude*, generally written *Diff. Lat.*

The *latitude left* (written *Lat. left*) may be a point of land, an island, or a lighthouse; or it may be a spot on the ocean where, at any hour, an astronomical observation had been taken to determine the position, and from which we had departed.

The latitude arrived at (written *Lat. in*), if not determined by an observation, is obtained by applying the northing or southing made good to the latitude left.

Thus Lat. left $\pm$ Diff. Lat. = Lat. in.

The *middle latitude* (written *Mid. Lat.*) between two places is the latitude of the parallel passing midway between them; hence half-way between the Lat. left and Lat. in.

The *Longitude* of a place is the angular distance of the meridian passing over the place from the first meridian, reckoned on the equator. With us the first

meridian* is that of Greenwich Observatory, which is Long. 0°; and thence longitude is reckoned *East* or *West* to 180°.

The difference of longitude is written *Diff. Long.*; but you must note that a ship, when she sails eastward or westward, though she makes difference of longitude, does not make it under that name; in fact, the east or west distance by which she has departed from any meridian is called *Departure*, which has to be converted into difference of longitude by calculation, by inspection (as will presently be shown), or by projection, as on p. 33 ; and you will further note, that it is only on the equator that the minutes (′) of longitude coincide with the miles of departure; everywhere else a given number of miles of departure makes a greater number of minutes of longitude; thus, on the 60th parallel, 30 miles of departure make 60′ or 1° of longitude.

Let us suppose our departure (written *Dep.*) converted into Diff. Long.; then, being in Long. E., if our Diff. Long. be E., we increase our longitude, or distance from the meridian of Greenwich, but if our Diff. Long. is W., we decrease it. Similarly, being in Long. W., Diff. Long. W. will increase it, but Diff. Long. E. will decrease it.

Much that has been said of latitude now also applies to longitude.

Longitude left (written *Long. left*) implies the meridian whence the ship departed; and longitude in (written *Long. in*) is the meridian at which the ship has arrived.

And Long. left ± Diff. Long. = Long. in.

You can readily see that when a vessel sails *true* South or North, she does not change her longitude,

* Meridians are great circles passing through both poles, and perpendicular to the equator.

though, of course, she has changed her latitude. And, conversely, if a vessel sails *true* West or East, she alters her longitude, though she has not changed her latitude. When she sails on any other course than *true* West or East, or *true* North or South, she alters both her latitude and longitude.

THE USE OF CHARTS.

The learner should supply himself with a small chart of the World, and one of the English Channel, which we will now suppose to be before him.

Charts are representations of parts of the surface of the globe, constructed in such a manner as shall be most serviceable to the navigator. The projection used is that known as MERCATOR'S, on which all the meridians are equidistant straight lines, and the distance between successive parallels increases polarwise (*see* Chart, p. 20).

I will explain this projection. You know that on the globe the parallels of latitude are small circles parallel with the equator, and that the distance between any two near the equator is practically the same as that between any two nearer the pole. On the other hand, the meridians converge towards, and meet at, the poles; they are widest apart at the equator, and the distance between any two meridians has already decreased, in latitude 60°, to half what it is at the equator. For the purposes of Navigation a map on the globular projection is useless. But what would be the consequence if the parallels and meridians were projected into equidistant straight lines, as on the old plane charts?—great distortion of such parts of the earth's surface as lie in the higher latitudes; and it is wonderful how the old navigators did so much with them.

The plane surface of the chart, to be useful in Navigation, must preserve the relations of length and breadth as they exist on the spherical surface of the globe; and herein consists the excellence of Mercator's Chart. The meridians are parallel straight lines, and the degrees of longitude are all equal and equidistant; hence, contrary to what is actually the case on the surface of the globe, the meridians are as wide apart in the higher latitudes as on the equator. To compensate for this distortion the parallels of latitude, which are parallel with the equator and at right angles to the meridians, have the degrees of latitude unequal, being extended in length in the same proportion as the degrees of longitude on the globe diminish; and, consequently, the extension is the greater the greater the distance from the equator. The table used in the construction of such a chart is that called *Meridional Parts* (Tab. VI.); it gives the increase in length of small portions of the meridian, expressed in minutes of the equator. The most important advantage possessed by this kind of projection is the representation of the bearing and course between any two places as a straight line, which corresponds with the most important apparent fact in the mind of the seaman.

Mercator's Projection has been compared to a cylinder unrolled: the cylinder, of indefinite length, being such an one as we might suppose to circumscribe the globe at the equator.

The outermost parallels (see Chart on p. 20), at the North and South parts (top and bottom) of the chart, are the *graduated parallels on which longitude is measured* —nothing else; distance never.

The outermost meridians, on the East and West (right and left) sides of the chart, are the *graduated meridians on which distance and latitude are measured.*

The term *graduated* implies division into degrees; and when the scale is large into minutes (miles) of arc also.

The North point of the compass on the chart is always indicated by a *fleur-de-lis*, or other device; in the true compass the N. and S. line coincides with the meridian.

To find the course by the chart between any two places, A and B: lay the edge of the parallel rules over the two places, then slide them (preserving the direction) till the edge of the rule is on the centre of the nearest compass, and read off the course indicated.

The *bearing* of a place from the ship is got by a similar process. If the compass is true, allow *easterly* variation to the *left*, *westerly* variation to the *right*, to get the correct magnetic course to be steered.

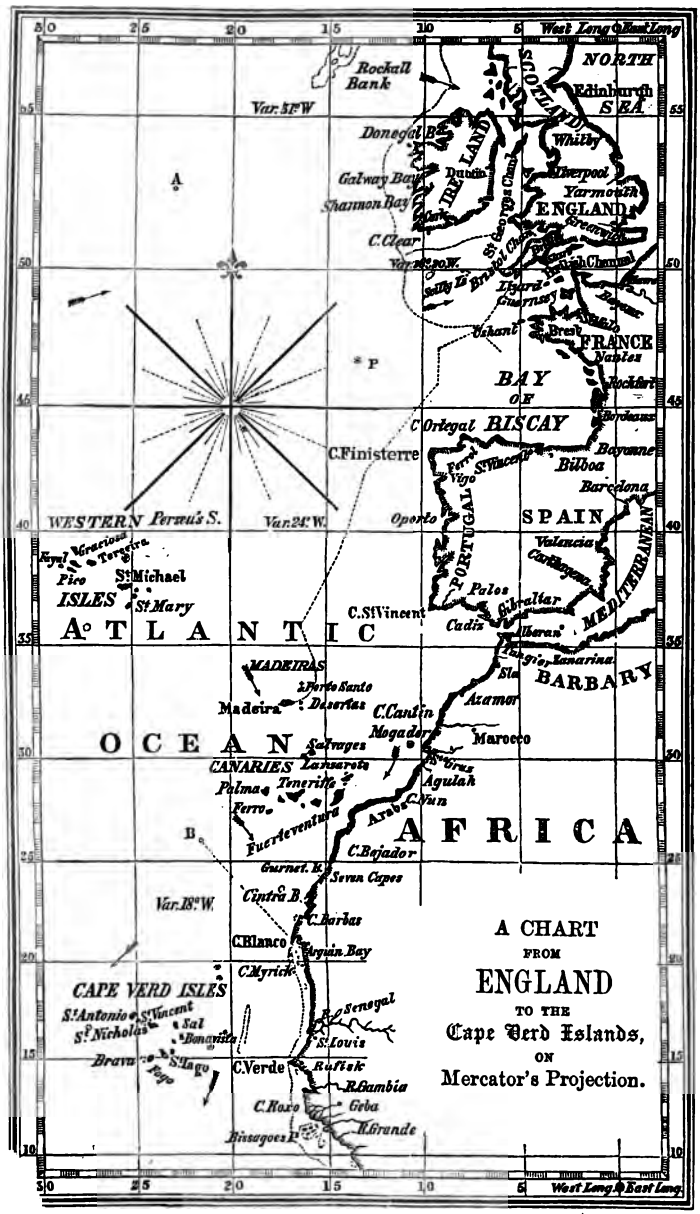
To find the distance between those two, or any other two places on the chart: measure off with a pair of dividers *half* the distance between them; opposite the middle point, *on the graduated meridian*, place one leg of the dividers, and with the other leg measure upwards and downwards; the number of degrees (converted into miles) between the two extreme points gives the distance nearly.

To find the latitude of a place by the chart: take between the points of the dividers its distance from the nearest parallel, and refer this distance to the same parallel on the graduated meridian; then read off.

To find the longitude of a place by the chart: take between the points of the dividers its distance from the nearest meridian, and refer this distance to the same meridian on the graduated parallel; then read off.

By a similar process a ship's place on the chart is pricked off.

The *soundings*, in fathoms or feet, as specified on the chart, are given for low water ordinary spring tides


A CHART
FROM
ENGLAND
TO THE
Cape Verd Islands,
ON
Mercator's Projection.
NORTH SEA
SCOTLAND
IRELAND
ENGLAND
FRANCE
SPAIN
PORTUGAL
BAY OF BISCAY
MEDITERRANEAN
BARBARY
AFRICA
OCEAN
ATLANTIC
WESTERN Peruvis S.
CAPE VERD ISLES
CANARIES
MADEIRAS
Rockall Bank
Var. 32°W
Donegol B.
Galway Bay
Shannon Bay
C. Clear
Var. 22°30'W.
Scilly
Ushant
Brest
Nantes
Rochfort
Bordeaux
Bayonne
Bilboa
Barcelona
Valencia
Carthagena
Palos
Gibraltar
Cadiz
Tangier
Tetuan
Larache
Azamor
Mogadore
Marocco
Saffrages
Arguin
Agulah
C. Finisterre
C. Ortegal
Oporto
Vigo
Ferrol
St. Vincent
C. St. Vincent
C. Spartel
Liverpool
Yarmouth
Dublin
Whitby
Edinburgh
Var. 24°W.
Var. 18°W.
Madeira
Desertas
Porto Santo
Lanzarote
Palma
Teneriffe
Ferro
Fuerteventura
C. Bojador
C. Barbas
C. Blanco
C. Myrick
C. Verde
Senegal
St. Louis
Rufisk
R. Gambia
Geba
R. Grande
Bissagoes
Gurnet. I.
Seven Capes
Cintra B.
St. Antonio
St. Nicholas
St. Vincent
Sal
Bonavista
Brava
Fogo
St. Iago
Sierra Leone
Canary
Lancerota
Araba
C. Nun
Sta
West Long
East Long

What is the distance from the western extremity of Cherbourg Breakwater to the Needles Light? Also the true course, and the magnetic bearing or course by compass?

Ans. Distance 59¾ miles—true bearing about N. ¼ E. —course to be steered by compass N.N.E., the variation being 20½° W. in 1880.

This result is thus arrived at: the compasses are placed with a point at each of the given places, and they are then applied to the nearest graduated meridian at the side of the chart. The large parallel rulers are then placed with the edge lying from place to place; the rule is then worked to the engraved compass on the chart, showing the true and the magnetic bearings, when it will easily be seen how the true and compass course is ascertained.

When two distant objects are recognised, the ship's place may be thus pricked down on the chart.

Ex. Going down Channel, the Start Point bore by compass E.N.E., and the Eddystone bore N. ¾ W. Apply the parallel rule to the engraved magnetic compass, lying along the E.N.E. point, and work the rule until its edge touches the Start Point or Light, and draw a pencil line along its edge on the chart. Apply, in like manner, the N. ¾ W. line to the Eddystone. Where these two lines cut each other, there is your vessel. Apply the respective distances of the two points from the ship to the nearest graduated meridian, and it will be found that the Start is 22½ miles, and the Eddystone about 15½ miles, distant from your vessel.

To ascertain the ship's place from only one known point, will be explained by the method of "taking a departure," farther on.

What is the course and distance from Cape Finisterre to the eastern extremity of Madeira?

Ans. Distance 11° 40′ or 700 miles; true course S.S.W. ½ W. (westerly). Should the variation be two points westerly, then the compass course will be S.W. ½W. The distance was found after placing the compasses on each position, by transferring them to the graduated meridian at the side of the chart, nearly opposite the two points in question, with one point of the compasses as much above one position as the other point is below the other position. Here it will be found, that one point of the compasses being on latitude 32°, the other point will rest on latitude 43° 40′, when there will be 11° 40′ of latitude between them; and as each degree equals 60 miles, the distance in miles will be 700. For great distances the middle latitude should be found.

Ex. The ship by observation is found to be in lat. 46° 38′ N. and long. 13° W. "Prick the ship's place" on the chart.

Ans. On or close to the spot marked P on chart, p. 20.

Ex. The ship sailed from the eastern extremity of Madeira 517 miles or knots; true course N.W. ¾ W.—where is she?

Ans. Off the eastern extremity of St. Michael's, Azores.

TIDES.

The time elapsing between two high waters may be said to be 12½ hours; thus, if it is high water at noon, it will again be high water at 12½ in the night—low water occurring in the intermediate time.

To know the time of high water, put down the time of the moon's meridian passage for the day, taken from page iv of the month in the Nautical Almanac: to this add the time of high water on the full and change of the moon at or near the port required, from the Tide

Table of the Nautical Almanac, or any other Tide Tables. From their sum subtract 12 hours 24 minutes, or 24 hours 48 minutes, as the sum may exceed those numbers, and the remainder will be the time of high water always at P.M.

Ex. When will it be high water at Dublin Bar, July 28, 1882 ?

	H.	M.	
Moon's meridian passage . .	10	29	(Naut. Alm., July, p. iv.)
Dublin Bar (H. W. at F. & C.)	11	12	
	21	41	
	12	24	
Ans. High Water at Dublin .	9	17	P.M.

Note.—The high water (F and C) for Dublin Bar is taken from the Tide Table of the Nautical Almanac for 1882, p. 470.

But if you look to pp. 468-7 of Nautical Almanac for 1882 you will there see the *mean time of high water at London Bridge* for every day in the year, respecting which read the instructions at the end of the Almanac: on the two following pages you will find the time of high water, on the full and change of the moon, for a number of places around and near the British Islands; these are the tidal *Establishment* for the given ports. Now, for any given port take the difference between its establishment and that of London Bridge, which is 1h. 58m. This difference is a *constant* to be applied, according to the following rule, to the tidal hour at London Bridge for any given day, to get the A.M. and P.M. times of high water at the required port.

Rule.—If the tidal establishment at the port is greater than that at London Bridge the *constant* is to be added ; if otherwise, subtracted.

Ex. Find the time of high water A.M. and P.M. at the Land's End, June 20, 1882. The establishment a^t

the Land's End being 4h. 30m., and that at London Bridge 1h. 58m.; the difference, 2h. 32m., is the constant to be added to the London Bridge times.

	H.	M.		H.	M.	
London Bridge. . . .	4	40	A.M.	4	59	P.M.
Constant + ...	2	32		2	32	
For Land's End . . .	7	12	A.M.	7	31	P.M.

But the best book for your use is that entitled "Tide Tables for the British and Irish Ports," published every year by the Hydrographic Department of the Admiralty. It is full of information respecting the tidal hours and streams around the British Islands; gives the constants to be applied; and the tidal establishments of all the principal ports on the globe.

LEEWAY.

If, at particular times, especially when close-hauled with a stiff breeze, you look astern, you will see that *the wake of the ship makes an angle with her fore and aft line.* Hence it is quite certain that she cannot be progressing in the direction of her apparent course; this angle is termed *leeway*, as the tendency is to leeward, or *from the wind.* The build and trim of the ship, the quantity and set of sail, closeness to the wind, velocity through the water, &c., all have their effect in producing leeway, which, when made, must be allowed for on the course steered, to the *right* if on the *port tack*, to the left if on the *starboard tack*, and it must be put down in the log as a $\frac{1}{4}$, $\frac{1}{2}$, or whole point, or more as you estimate it.

Ex. Course by compass N.N.E., wind N.W. *b* N., with $\frac{1}{2}$ point of leeway, gives corrected course N.N.E. $\frac{1}{2}$ E.

Ex. Course by compass S.E., wind S. *b* W., with $\frac{3}{4}$ point of leeway, gives corrected course S.E. $\frac{3}{4}$ E.

SAILING.

The various denominations of Sailing are—Plane Sailing, Traverse Sailing, Parallel Sailing, Middle Latitude Sailing, Mercator Sailing, Current Sailing, and Great Circle Sailing; all these, except the last, are more or less connected with the solving of a *Day's Work*. Plane Sailing is the resolution of the difference of latitude and departure from a given course and distance, and *vice versâ*. Traverse Sailing is the determination of the course and distance made good derived from a number of courses and distances sailed within a limited time. Parallel, Middle Latitude, and Mercator Sailing are used in connection with the Day's Work in finding the longitude in ; but they are also useful in other parts of Navigation, especially the latter sailing, by the aid of which we arrive at the course and distance between two distant ports. The different methods of solving these are by—1. Construction ; 2. Calculation ; and 3. Inspection.

The method by inspection is that in general use among navigators ; the solutions are obtained by the aid of *Traverse Tables* 4 and 5, and by Table VI. called *Meridional Parts*. I shall here collect together the Rules appertaining to the use of these Tables. These Rules, and the examples attached to them, you should carefully go through, so that in subsequent parts of the work it will merely be necessary to briefly refer to them ; you should also endeavour to acquire great aptitude in the use of the Tables for the different purposes to which they are applicable.

I must also remark that for those who like to see a solution of a problem by means of a diagram or mathematical figure, the *method by construction* has been introduced.

GIVEN THE COURSE AND DISTANCE TO FIND THE DIFFERENCE OF LATITUDE AND DEPARTURE.

Note.—If the course is in points of the compass use Traverse Table 4, if in degrees use Table 5. Also, if the course is less than 4 points, or 45 degrees, enter the Table, reading the headings of the various columns from the top of the page; if the course exceeds 4 points, or 45 degrees, read from the bottom of the page.

Ex. Course N. *b* E. $\frac{1}{2}$ E. (*i.e.* $1\frac{1}{2}$ points), and dist. 39 miles, give diff. lat. 37·3′ N., and dep. 11·3′ E.

Ex. Course N.E. $\frac{3}{4}$ E. (*i.e.* $4\frac{3}{4}$ points), and dist. 81 miles, give diff. lat. 48·3′ N., and dep. 65·1′ E.

Ex. Course N. 37° W., and dist. 58 miles, give diff. lat. 46·3′ N., and dep. 34·9′ W.

Ex. Course S. 61° E., and dist. 94 miles, give diff. lat. 45·6′ S., and dep. 82·2′ E.

Should the distance exceed 300 miles, halve it, and enter the Table with the half; then, having taken out the corresponding diff. lat. and dep., double them.

Ex. Course 40°, and dist. 422; turn to course 40°, and dist. 211, which give diff. lat. 161·6′, and dep. 135·6′; these doubled give diff. lat. 323·2′, and dep. 271·2′.

Note.—You can understand that if your course is less than 4 points, or 45 degrees, you are sailing nearer to a meridian than to a parallel, and hence making more northing or southing than easting or westing. With the course greater than 4 points, or 45 degrees, you are sailing nearer to a parallel than to a meridian; and, therefore, making more easting or westing than northing or southing. Difference of latitude must be N. or S.; departure must be E. or W. With the course exactly 4 points, or 45 degrees, the diff. lat. and dep. are equal.

GIVEN THE DIFFERENCE OF LATITUDE AND DEPARTURE TO FIND THE COURSE AND DISTANCE.

Note.—Use Traverse Table 5; then, if diff. lat. is greater than dep. enter Table, reading the columns from the top of the page; if dep. is greater than diff. lat. read from the bottom. If you do not find the exact numbers, take the nearest to them.

Ex. Diff. lat. 63·8′ N., and dep. 17·1′ E., give course N. 15° E., and dist. 66 miles.

Ex. Diff. lat. 45·7′ S., and dep. 93·4 W., give course S. 64° W., and dist. 104 miles.

Note.—You will see that the course is named *from* N. or S. *towards* E. or W., according to the diff. lat. and dep.

PARALLEL SAILING BY INSPECTION.

Note.—When sailing on a parallel, distance and departure are convertible terms.

To find the difference of longitude.—Enter Traverse Table 5 with the given latitude, as if it were a course, and find the departure in "Lat." column, then the corresponding distance in "Dist." column will be the Diff. Long. required.

Ex. On the parallel of 50°, the dep. made being 60·4 miles, in Trav. Tab. 5, with course 50° and dep. 60·4, sought in "Lat." column, gives 94′ in the "Dist." column, which is the diff. long.

MIDDLE LATITUDE SAILING BY INSPECTION.

To find the difference of longitude.—This is like parallel sailing. Use Traverse Table 5; with the Mid. Lat. as a course and dep. in "Lat." col., the Diff. Long. is found in the "Dist." col.

Ex. Mid. lat. 44°, and dep. 103′ (in "Lat." column), give diff. long. 143′ in "Dist." column.

Ex. Mid. lat. 51½°, and dep. 96·2′; take 51° and dep. 96·3′ (in "Lat." column), for diff. long. 153′; then 52°, and dep. 96′, give diff. long. 156′; hence, the sum of 153 and 156 divided by 2 gives 154½′ as the diff. long. for mid. lat. 51½°.

Note.—When making up the Dead Reckoning, if the Lat. is less than 55°, the Diff. Long. as found by the method of Middle Latitude is sufficiently accurate for the ordinary purposes of Navigation.

MERCATOR SAILING BY INSPECTION.

To find the difference of longitude.—From Table VI. take out the "Meridional Parts" for the Lat. left and Lat. in. When both latitudes have the same name take the difference of the Mer. Parts, but when one latitude is N. and the other S., take the sum of the Mer. Parts, for the *meridional difference of latitude.* Then, enter Traverse Table 4 or 5 with the course, and find the Mer. Diff. of Lat. in "Lat." column, from the side of which take out the "Dep." for the required Diff. Long.

Ex. Lat. left 49° 50′ N.	Mer. parts (Tab. VI.) . .	3459
Lat. in 51° 40′ N.	„ „ . .	3633
	Mer. diff. lat.	174

Let us say the course made good is N.W. by N., or N. 3 pt. W.

Then, by Trav. Tab. 4; under 3 points, with Mer. Diff. Lat. 174 in "Lat." col., we get in Dep. col. 116 for Diff. Long.

General Note.—When near the Equator, and the Latitude is less than 4° or 5′ the Departure may be taken as the Diff. Long.

General Observations.—It is first necessary to find the ship's place by the Dead Reckoning, or by Account,

as it is frequently termed. The Dead Reckoning is an account of the ship's circumstances from the noon of one day to the noon of the next, which account is hourly kept on what is called the log-board, the contents of which are termed *the log*,—the working it off, *the day's work*.

When we read from the log that the ship at noon was close in at the Lizard Point, and that until 3 P.M. she sailed W. at 6 knots or miles an hour, it is a very simple operation to discover that she may be 18 miles W. of the Lizard. But when we have to take into the account the variation of the compass, the force and direction of the tide, and the quantity of leeway, the investigation becomes more complex. What is required to be accurately learnt is, the true rate at which the ship changes her place, and the real direction or course she takes.

Supposing the Patent, or other log, to denote a speed of 7 knots an hour, it by no means follows that the ship is making good that rate; for should she be going against a tide flowing 3 knots an hour, the vessel has changed her place by only 4 knots; and conversely, should she have had a similar tide in her favour, she has accomplished a distance of 10 miles; this deduction or addition of the rate of tide must be alone guided by experience, the force of the stream varying at every hour of the tide. When the ship is well out at sea, she is not affected by the tide, as it creates no stream; in the open ocean the tidal wave sweeping along, but causing no more current than an ordinary billow. But, on the other hand, ocean currents exist independently of all tide, and are sometimes constant, sometimes variable, both in strength and direction. These probably have been as disastrous to shipping as they are practically imperceptible, and to be detected

only by the ship's place found by Observation being widely different from that by Account. Should you be becalmed, a boat may be put out, from which is lowered to a great depth some heavy weight; when, the boat remaining as still as though it was anchored, by observing the course and drifting of the ship from the boat, an estimate may be formed of the direction and velocity of the current.

The estimated current should be carefully noted in the log; also the quantity of leeway, as a quarter, half, or whole point of the compass, attached to the course on which it is made; the direction of the wind and hourly rate of sailing; not forgetting the variation for the locality you are navigating; and the deviation of the compass if the ship is of iron, or composite.

A DAY'S WORK.

The reader is now assumed to have a clear understanding of the preparatory work of Navigation, and I shall proceed to the *day's work.*

There are *two kinds of days*—the *astronomical* or seaman's day, and the *civil* or landsman's day. The latter commences at midnight, and terminates at the following midnight, being divided by noon, the time before noon being noted as A.M. (*ante-meridiem*), the latter division being noted as P.M. (*post-meridiem*).

With the astronomical day it is always P.M.; for, instead of from midnight, it commences at noon, and continues until the succeeding noon. Thus, what a landsman or civil time would indicate by June 21st, 3 hours A.M., *i.e.* 3 hours after midnight, the sailor or the Nautical Almanac would express as June 20, 15 hours; but this latter expression will not come into use until we are required to find our longitude by chronometer, as explained farther on.

In keeping the log, the day, as already observed, commences at noon, and terminates on the following noon. The hours are placed in succession, but instead of carrying them on to 24, they recommence after 12, in accordance with the arrangement of time-pieces. The first figure put down on the log-board is 1, meaning one o'clock. Whatever then is written down to that figure indicates what has occurred from the previous hour up to that hour: thus, the first line of the following table indicates that from noon to one o'clock the

H.	K.	F.	Courses.	Winds.	Leeway.	Remarks.
1	4	2	W.	S.S.W.	1¼	
..	..	..	.. ..	..	..	
..	..	..	.. ..	..	..	
..	..	..	.. ..	..	..	
..	..	..	.. ..	..	..	
..	..	..	.. ..	..	..	
..	..	..	.. ..	..	..	
..	..	..	.. ..	..	..	
9	5	6	S.W. *b* W.	S. *b* E.	1½	
..	..	..	.. ..	..	..	

H. K. F. denote the columns appropriated to the hours, knots, and furlongs made good during these hours.

ship has sailed 4 knots (or miles) and 2 furlongs (¼ mile); the course was West by compass, the leeway amounted to one point and a quarter of the compass, which must be allowed from the S.S.W. wind which was blowing. Again, the last line of the table indicates that from 8 till 9 o'clock the ship sailed 5 knots and 6 furlongs, steering by the compass a S.W. *b* W. course, with one and a half points of the compass to be allowed for leeway from the wind. And similarly for other hours through the 24.

This to the learner may at first appear to be somewhat puzzling, but it will soon cease to be so, if taken in its proper time.

Ex. Supposing a ship has sailed true S.W. 80 miles from the Land's End, we thus set about to find her place on the chart.

1. *By Inspection.*—Enter Trav. Tab. 4, with course, 4 points (S.W.) and 80 miles of dist.; we get diff. lat. 56·6′ S. and dep. 56·6′ W.

(Land's End) lat. left	50°	4′ N.	Mer. parts (Tab. VI.)		3481
Diff. lat. 56·6′, say	57	S.			
			,, ,, ,,		3393
Lat. in	49	7 N.	Merid. diff. lat.		88
Sum of lat. left and in	99	11			
Middle lat.	49	35			

Entering Tab. 5 with mid. lat. 49½° as a course and dep. in lat. column we get 87′ as diff. long. in dist. column.

Or, in Tab. 4, entering with course 4 points (S.W.) and merid. diff. lat. 88 in lat. column, we get 88 as diff. long. in dep. column.

Then, (Land's End) long. left 5° 43′ W.
Diff. long. 87′ W. = 1 27 W.
By Mid. lat.; Long. in = 7 10 W.

Hence a *true* S.W. course and run of 80 miles from the Land's End brings us into Lat. 49° 7′ N., Long. 7° 10′ or 7° 11′ W., according to whether we take Middle Latitude or Mercator Sailing; and this position you can prick on the chart.

We shall now proceed to show the method by *Construction*. With the pencil-compass we form any conveniently sized circle; then, drawing two diameters cutting each other at right angles, the four extremities now represent the cardinal points of the compass (see fig. 3).

Each quarter of the mariner's compass is divided into 8 points, and we now set the pointed compasses so that the space between their points shall equal an eighth of a quarter of this compass; in other words, one point being on *S*, the portion of the circle between *S* and *W* contains just eight of the spaces between the

points of the steel drawing compass. Now S.W. (the ship's true course) is south, 4 points towards the west. Place the compasses then on *S*, and count off 4 points in the direction of *W* to *a*; *b* will represent the point sailed from, or the Land's End,—*b a*, the true course steered. From *b* through *a* draw a line of any convenient length, and from the scale on the protractor take with the compasses a space equal to 80 miles, which prick off from *b* on the line *b a*. We will suppose *c* to be the

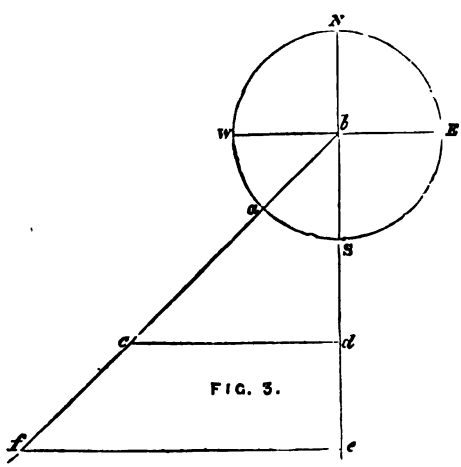


FIG. 3.

point to which the compasses reach, and which will now represent the ship's place. From this point draw *c d* at right angles to *b S* produced any length to meet it; or, which is the same thing, parallel to the line *W E*; to do which, place the parallel ruler along *W E*, and work it to *c*, and draw from *c* the line *c d*. This triangle will now exhibit the following: the angle *c b S* formed by the lines *b c*, *b d*, will be the course made good; *b c*, the distance made good; *b d*, the difference of latitude; and *d c*, the *departure*, wh

is not termed the *difference of longitude*, because, owing to the meridians converging towards the poles, the proportions of this line will not truly represent the difference of longitude.

As, in our figure, *b c* equals 80 miles, on taking *b d* in our compasses and applying it to our scale, we shall find it equal to 57 miles, which is now our difference of latitude. We must now learn our difference of longitude, which is not truly represented by *c d*, and for which purpose we must have recourse to Table VI.

(Land's End.)	Lat. left	50° 4′	N.	Meridional parts	3481
	Diff. of lat.	0 57	S.		
	Latitude in	49 7	N.	Meridional parts	3393
				Meridional diff. of lat.	88 miles.

As we have sailed southerly, we must have lessened our northern latitude; therefore 57 miles, our difference of latitude, must be subtracted to give us our latitude in, the meridional parts of which being subtracted from those of the latitude left, give the meridional difference of latitude, viz. 88 miles, which, being measured in the direction of *b d*, give us *b e*. From the point *e* draw *e f* parallel to *d c*; *e f* is our true difference of longitude in miles, which must be added to, or subtracted from, the longitude left, accordingly as we have increased or diminished our distance from Greenwich, *i.e.* have been sailing westerly or easterly. Here we must add the difference of longitude to the longitude left, to find the longitude in, as we have sailed westerly, and increased our distance from Greenwich (see p. 32).

We are now, I trust, prepared to deal with the following *day's work*, noted down on the log-board;

THE LOG-BOARD. No. I.

H.	K.	F.	Courses.	Winds.	Leeway.	Remarks.
1	5	4	S.W.	N. *b* W.		Latitnde at noon,—
2	5					48° 53′ N.
3	5					Long. 10° 19′ W.
4	4	4		N.W. *b* N.		
5	4					
6	4		W. *b* S.		½	
7	4					
8	3	6				
9	3	2				
10	3					
11	3		N.W. *b* W.	S.W. *b* W.	1	
12	3					
1	2					Variation,—
2	2					2¼ points W.
3	3					
4	4					
5	4					
6	4	4	S. *b* E.		½	
7	4	4				
8	5					
9	5					
10	5		W.	S.S.W.	¼	
11	5					
12	5					

Course.	Dist.	Diff. of Lat.	Dep.	Latitude N.		Diff. of Long.	Longitude W.		Bearing and Dist. of Madeira.
				Acc.	Obs.		Acc.	Obs.	
S. 42° W.	64m	47′ S.	42′ W.	48° 6′		64′ W.	11° 23′		S. 14½° W. 954 m.

supposing that we had left a port in Ireland, and had arrived at Lat. 48° 53′ N., Long. 10° 19′ W., which we will take as a point of departure. The meaning of the above is, that from 12 at noon until 5 o'clock the distance run was 24 miles, course S.W. with the wind N. *b* W. and N.W. *b* N., but making no leeway. From 5 o'clock until 10 the run was 18 miles, the compass course W. *b* S., wind still N.W. *b* N., and the ship making leeway to the amount of ½ a point of the compass,—and so on with the rest of the log.

DAY'S WORK BY INSPECTION.

We will proceed to get the result of the above *day's work by inspection;* I will set it down in full, and afterwards explain it *seriatim,* in which case you can readily refer back.

True Courses.	Dist.	Diff. Lat.		Departure.	
		N.	S.	E.	W.
S. 1¾ W.	24		22·6		8·1
S. 4¼ W.	18		12·1		13·3
N. 6¼ W.	21	7·1			19·8
S. 3¾ E.	19		14·1	12·8	
S. 6 W.	15		5·7		13·9
		7·1	54·5	12·8	55·1
			7·1		12·8
		Diff. Lat.	47·4	Dep.	42·3

Diff. lat. 47·4′ S. } give in Trav. Tab. 5 { Course S. 42° W.
Dep. 42·3′ W. } { Dist. 64 miles.

Lat. left .	48°	53′ N.	Long. left . .	10°	19′ W.
Diff. lat. .	0	47 S.	Diff. long. . .	1	4 W.
Lat. in . .	48	6 N.	Long. in . .	11	23 W.
Sum of lats.	96	59			
Mid. lat. .	48	30			

Mid. lat. 48½° as course. } In Trav. Tab. 5 give 64 in "Dist."
Dep. 42·3′ in "Lat." col. } col., which is diff. long.

Finally, prick off the ship's place on the chart in lat. 48° 6′ N., long. 11° 23′ W., which is the result of dead reckoning, if you have not the position by observation.

1. The courses steered have to be corrected for leeway (if any), and for variation. The first course on the log-board, p. 35, is S.W. with no leeway, but corrected for Var. 2¼ points W. (to left hand) gives *true* course

S. *b* W. $\frac{3}{4}$ W., or S. $1\frac{3}{4}$ pt. W.; the total distance run on that course is 24 miles. The second course steered W. *b* S. has $\frac{1}{2}$ pt. leeway with the wind N.W. *b* N., which allowed to left (*from the wind*) gives W. *b* S. $\frac{1}{2}$ S.; and this corrected for Var. $2\frac{1}{2}$ pt. W. gives S.W. $\frac{1}{4}$ W., or S. $4\frac{1}{4}$ pt. W., with distance 18 miles; and similarly with the other courses and distances.

2. Having got the *true* courses, draw a tabular form as shown, and mark the headings as you see on p. 36; then enter the true courses in the first column, and the distances run on each course in the second column.

3. Enter Traverse Table 4 with the first course and distance, and take out the diff. lat. and dep. corresponding; in this case course $1\frac{3}{4}$ points and dist. 24, give diff. lat. 22·6 and dep. 8·1; the diff. lat. being entered in S. col., and the dep. in W. col., because course is S. and W. Proceed similarly with the other courses and distances, and fill in the N., S., E., and W. columns.

4. Next find the sum of each of columns marked N., S., E., and W.; after which take the difference between the N. and S. quantities for the *true* diff. lat.; also take the difference between the E. and W. quantities for the *true* departure.

5. With the true diff. lat. and dep. just found, enter Traverse Table 5 for the course made good, and the corresponding distance (see p. 36, and also p. 27). The course must be named after the diff. lat. and dep., in this case S. and W.

6. To the lat. left apply the diff. lat. to get the lat. in or arrived at; in this case, being in lat. N., and having made southing you have decreased your lat. (see p. 15).

7. Proceed to find the middle latitude—*i.e.* the lat. midway between the lat. left and lat. in.

8. Enter Traverse Table 5 with the mid. lat. as if it were a course of so many degrees, and run the finger down the lat. column until you find the number corresponding to the dep.; in the annexed column of distance you will find the number of miles that must be taken as the diff. long.

9. To the long. left apply the diff. long. to get the long. in; in this case the ship being in long. W., and having made westing, you have increased your long. from Greenwich.

This explanation, with what has previously been said in other parts of the work, will be sufficient, if you have carefully read the rules, studied the examples, and gone through the foregoing day's work in such manner as to understand its meaning. *The method by inspection is that used at sea.*

Other days' works will be given, but I shall merely work them out by inspection, leaving you to follow the different results step by step.

It now remains to show you the method by construction.

DAY'S WORK BY CONSTRUCTION.

Let every *day's work* that you intend to project be done in the following manner; and let every part of the work be put down in the same part of the paper, which will serve much to prevent confusion or mistakes.

I will first give some information as regards the scale on which the diagram is to be formed. Let your compass representation be on a large scale, and your traverses on a small one. Take, then, the protractor, and observe the notch (|) thus in the centre of its lower edge, as previously mentioned; put one point of the pencil-compasses to this, and extend the pencil to the outer extremity of the protractor. With this dis-

tance form a circle, and draw a diameter up and down the paper: the extremities of this will now represent the N. and S. points of the compass. We must now draw another diameter at right angles to this one. To do this, place the notch to the centre of the circle, and with the edge of the protractor lying along the N and S line, opposite the line 90, on the opposite edge of the scale, make a mark on the paper; through this mark and the centre of the circle draw the diameter W E, which will be at right angles to the line N S, and its extremities will now represent the W. and E. points of our compass (see fig. 4).

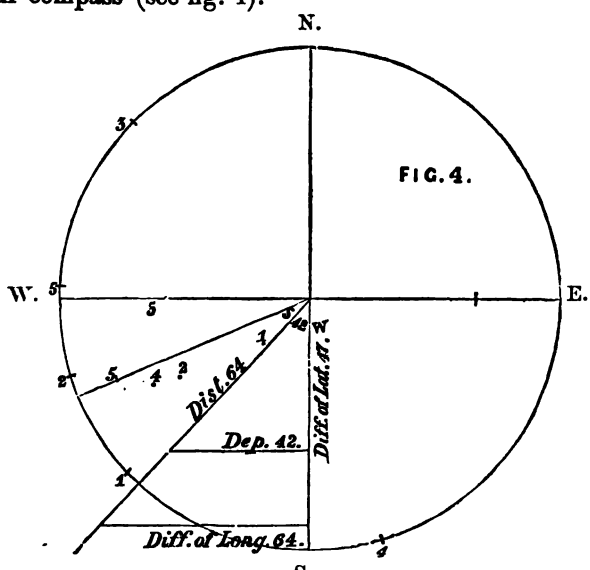


FIG. 4.

1	S.W.	24
2	W. *b* S. $\frac{1}{2}$ S.	18
3	N.W.	21
4	S. *b* E. $\frac{1}{2}$ E.	19
5	W. $\frac{1}{4}$ N.	15

Variation $2\frac{1}{4}$ W.

We have now drawn the compass, and must look again at the log. We see that there are five courses steered which have to be *corrected for leeway:* then, on a corner of our paper, we place a kind of "*traverse table,*" adapted for the five courses, with the distances run on each, and the amount of variation beneath them (see p. 39). During the first course there was no leeway made; therefore the course is entered precisely as it is entered in the log. In the second course there was ½ point of leeway; this, as has been said, is to be allowed for from the wind, which, being N.W. *b* N., the course is entered W. *b* S. ½ S.: for similar reasons, the other courses will be as entered in our Table. The variation of the compass is to be noticed presently.

Open the pointed compasses so that their space shall divide the whole circle into 32 equal spaces; or what is the same thing, one-quarter of it into 8 equal parts. When this is accomplished, the space within the compasses will represent one point of the mariner's compass. When this quantity has been once ascertained to great exactness, find some measure of it on the protractor, to be preserved for all future occasions.

The first course being S.W., we wish now to know where in our compass this point will fall. Take the compasses just set, and count off 4 points from S. or W.; mark the spot on the circumference, and close to it, on the outside of the circle, write the figure 1. In marking the second course, do not alter the compasses, but, measuring one point from W., turn them on to the second point, and place by the eye the dot with its figure 2 midway between them. In a similar manner the other courses are to be marked on the circumference.

We must now bring into use the scale of little squares on the protractor, alluded to near the beginning of this

treatise (p. 6). As there explained, with another pair of compasses take off 24 miles; place the parallel ruler on the centre of the circle and on dot 1. Placing one point of the compasses on the centre of the circle, prick the paper at the edge of the ruler with the other point, close to which write figure 1. With the compasses take from the scale a distance of 18 miles; now place the parallel ruler running from the centre of the circle to fig. 2 on the circumference, and work the ruler until its edge falls on fig. 1, *within* the circle: in placing one point of the compasses on this point, place the other point along the edge of the ruler, and prick the paper as before, which mark as 2; and so on for the other courses, always commencing from the centre of the circle, and working the ruler to the preceding figure. When thus arrived at the last course 5, draw a line from it to the centre of the circle; and now we have to apply the variation of the compass, which in this instance being $2\frac{1}{4}$ points westerly, we must allow towards the left hand. Take the compasses which have been set to one point, and from where the line from 5 to the centre cuts the circle, count off $2\frac{1}{4}$ points; mark the place on the circumference, and draw a line from the centre through it, equal in length, to that from the centre to fig. 5. This last line will now give the true course steered and the distance made good, to ascertain which, we have only to apply the distance to our scale to know the number of miles (64), and the protractor to measure the angle or course steered, which will be found to be S. 42° W., or, measuring on the circumference of our drawn compass, S.W. $\frac{1}{4}$ S. As before explained, we now draw a line from the ship's place at right angles to N S or parallel to W E. This marks our difference of latitude made during the day: we take, then, the distance from where this cuts

the line N S to the centre of the circle, and, applying it to the scale, find it to be equal to 47 miles. Now, as we were in north latitude, and have sailed towards the south, we must have diminished our northern latitude; therefore these 47 miles must be deducted from the latitude left, placing us in lat. 48° 6′ N.

Lat. left	48° 53′ N.	Mer. parts 3371		Long. left	10° 19′ W.
Diff. of lat.	0 47 S.			Diff. of long.	1 4 W.
Lat. in	48 6 N.	Mer. parts 3301		Long. in	11 23 W.
		Meridional diff. of lat.	70		

From Table VI. we write down the meridional parts for the latitude left, as also the same for the latitude now in, and taking their difference, we have "the meridional difference of latitude," here equal to 70 miles. We take 70 miles in the compasses from the scale, and prick them off from the centre of our circle on the line N S produced to any length: from this last point we draw a line parallel to the line of departure until it cuts the line of distance produced to meet it. This last line, measured by the scale (64 miles), gives us our true difference of longitude. These 64 miles equal 1° 4′, and as we started in west longitude, and have sailed westerly, we have increased our west longitude; therefore this must be added to the longitude left, placing us in long. 11° 23′ W. Having now the latitude and longitude, we prick the ship's place on the chart.

From this spot we have now to determine the course to be steered for the next point to be made for, and its distance from us. In this instance it is Madeira. Place the parallel ruler on the ship's place and the island, and work it to the engraved compass which here gives S. *b* W. ¼ W. for the *true course:* apply the variation

2¼ points W. to the right hand, and we have S.W. ¼ S. for the *compass* course. Take the distance on the chart between the ship's place and Madeira, and apply it to the graduated meridian on the side of the chart, and we have about 954 miles for the distance. Or, the course and distance may be computed by Mercator's Sailing as on p. 55.

THE LOG-BOARD. No. II.

Note.—T signifies tenths of a knot.

H.	K.	T.	Courses.	Winds.	Lee-way.	Remarks.
1	6	0	N.W.	E.	0	Noon. Departure taken from the West point of Madeira in Lat. 32° 48′ N., Long. 17° 17′ W.; bearing by compass E.N.E. 12 miles.
2	6	5				
3	7	0				
4	7	5				
5	8	0	N.N.W.	E.N.E.	½	
6	8	0				
7	8	5				
8	8	5				
9	8	0	N.W. *b* N.	N.E. *b* N.	2	
10	7	5				
11	7	5				
12	7	0				
1	6	5	N.W.	N.N.E.	1½	
2	6	0				
3	5	5				
4	5	0				
5	5	2	W.N.W.	N.	1¼	For the last 10 hours a current setting S.S.E. by compass at 2½ miles per hour.
6	5	4				
7	6	3				
8	5	1				
9	5	0	N.E.	N.N.W.	1	
10	4	6				
11	4	3				
12	4	1				Variation 2 pts. W.

N.B.—The first course is the *Departure bearing*, to be reversed and corrected for Variation; then come the various courses in succession corrected for leeway and variation; lastly comes the direction of the current corrected for variation and entered as a course.

True Courses.	Dist.	Diff. Lat.		Departure.	
		N.	S.	E.	W.
S. 4 pt. W.	12		8·5		8·5
N. 6 W.	27	10·3			24·9
N. 4½ W.	33	20·9			25·5
N. 7 W.	30	5·9			29·4
N. 7½ W.	23	2·3			22·9
S. 6¾ W.	22		5·4		21·3
N. 3 E.	18	15·0		10·0	
S. 4 E.	25		17·7	17·7	
		54·4	31·6	27·7	132·5
		31·6			27·7
		22·8 Diff. Lat.		Dep. 104·8	

Diff. lat. 22·8′ N. } In Trav. Tab. 5 give { Course N. 78° W.
Dep. 104·8′ W. } { Dist. 107 miles.

Lat. left .	32° 48′ N.	Long. left . .	17° 17′ W.
Diff. lat. .	23 N.	Diff. long. 125′=	2 5 W.
Lat. in. .	33 11 N.	Long. in . . .	19 22 W.
Sum of lats.	65 59		
Mid. lat..	33 0		

Mid. lat. 33° as a course } In Trav. { Diff. Long. 125′
Dep. 104·8 in lat. col. } Tab. 5 give { in "Dist." col.

Note.—You could have solved this day's work without correcting the courses *seriatim* for variation, by merely correcting for leeway as it occurred, and then making *one correction for variation;*—by this process you would have got—

Diff. Lat. 61·2′ N. and Dep. 88·2′ W.

From these, the resulting Course and Dist. would be N. 55½° W. 107 miles. This Course corrected for 2 points, or 22½°, Westerly variation, to the left, would become N. 78° W. and Dist. 107 m.

Then, the newly corrected Course and Dist. would, by entering Trav. Tab. 5, give the correct Diff. Lat. and Dep. as in the worked example.

You can now take the following day's work; it is prepared for *construction*, but I will also give you the results by *inspection*.

By Inspection.—Diff. Lat. 52·2′ S.; Dep. 100·3 W.; Course S. 62½° W. Dist. 113 m.; Lat. in 44° 48′ N.; Diff. Long. 142′; Long. in 12° 27′ W.

THE LOG-BOARD. No. III.

H.	K.	F.	Courses.	Winds.	Leeway.	Remarks.
1	6	2	W. ½ S.	S. *b* W. ½ W.	1	2 P.M. Moderate breeze and fine weather.
2	6	3				
3	7		W.	S. *b* W.	½	3 P.M. Increasing, and squally.
4	7	2				
5	7	3	W. *b* S.		½	5 P.M. Fresh breeze with heavy sea from the south. Current assumed to be ½ mile per hour for the 24 hours, setting S.
6	7	1				
7	6	7	W.S.W.	S.	¾	
8	6	5				
9	6	3	W. *b* S.	S. *b* W.	1	
10	5	6				
11	5	5		Variable		A.M. Light airs and fine weather.
12	5					
1	4	2	W. ½ N.	S.S.W. ½ W.	2	
2	4	3				
3	4		W.N.W.	Variable		Lat. in at noon yesterday was 45° 40′ N. and Long. 10° 5′ W.
4	3	7				
5	3	7				
6	3	2				
7	3	1	W.			
8	3					
9	2	7				Variation of the compass, 2¼ points West.
10	2		W. ¾ N.			
11	2					
12	2		W. ¼ N.			

Course.	Dist.	Diff. of Lat.	Dep.	Latitude N. Acc.	Latitude N. Obs.	Diff. of Long.	Longitude W. Acc.	Longitude W. Obs.	Bearing and distance of ———
S.62½° W	113	52 S.	100 W.	44° 48′		142	12° 27′		

Traverse Table constructed from the above Log-board, with the Courses corrected for Leeway, and their respective Distances made good.

1	W. $\frac{1}{2}$ N.	$12\frac{1}{2}$
2	W. $\frac{1}{4}$ N.	$14\frac{1}{4}$
3	W. $\frac{1}{2}$ S.	$14\frac{1}{2}$
4	W. *b* S. $\frac{1}{4}$ S.	$13\frac{1}{2}$
5	W.	$22\frac{1}{4}$
6	W.N.W. $\frac{1}{2}$ N.	$8\frac{1}{2}$
7	W.N.W.	15
8	W.	9
9	W. $\frac{3}{4}$ N.	4
10	W. $\frac{1}{4}$ N.	2
11	Current, S.	12

Variation, $2\frac{1}{4}$ points.

Note.—In the Remarks, the current was setting S., that is, was carrying the vessel to the S., the effect of which is here put down as a S. course, distance 12 knots or miles, as it was affecting the ship's course half a mile per hour during the twenty-four.

The compartments at the foot of the log are appropriated to the result arrived at from the working off the Traverse Table, which the learner should now also work out, and compare the correctness of his solution with the one here given.

TO TAKE A DEPARTURE.

The bearing of the last headland likely to be seen from the ship is to be taken from two points, and the distance between these points is to be carefully noted by means of the log-line or patent log, and also the ship's course, until the headland nearly ceases to be seen.

Ex. At 3 P.M. the Lizard bore N. *b* W. $\frac{1}{2}$ W., and having sailed 7 knots an hour W. *b* N. $\frac{1}{4}$ N. until 6 P.M., the Lizard bore N.E. $\frac{3}{4}$ E. What is its distance from the ship?

By Construction.—Draw the compass, and let its centre be the ship's place at the first observation, and from it draw a line of any convenient length in the direction of the ship's course: also from the centre draw a line of any length of the same compass bearing as the headland when first observed. From the centre also draw a line of the same bearing as the headland when last seen. On the line of the ship's course prick off the distance made good, and at this point draw a line parallel to the last bearing that was taken, until it cuts the first line of bearing, at which spot the head-

land will now be supposed to be placed, and the measure of this last line drawn will give its distance (see fig. 5).

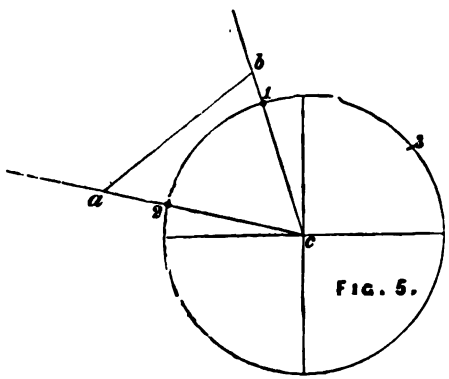


FIG. 5.

Here *c* 1 is the bearing of the Lizard from the ship at the first observation, *c* 2 is the course sailed, *c* 3 is the bearing of the Lizard at the last observation; *c a* is taken to equal 21 miles (the run of the ship). From *a* we draw *a b* parallel to *c* 3; *a b* is the distance of the Lizard from the ship at the last observation, and is equal to 19 miles.

In working off the log, the ship is now to be supposed to have set sail from close in with the Lizard, and this is to be entered as the first course and distance; and as the centre of our drawn compass will represent the Lizard Point, which last bore N.E. $\frac{3}{4}$ E. from the ship, a line diametrically opposite to this must be drawn, viz. S.W. $\frac{3}{4}$ W., and 19 miles measured on it; so that the first course of our Traverse Table will be—course S.W. $\frac{3}{4}$ W., distance 19 miles, and our latitude and longitude left will be that of the Lizard Point.

Note.—I now give the general rule for the solution by *Inspection*, which is the best method:—

Rule.—By Inspection:—When the angle between the first bearing and the course is more or less than 8 points.

Enter Trav. Tab. with the angle between the first Bearing and the Course as a Course, and the Dist. run (in Dist. col.), opposite which take out the Dep.

Then, enter Trav. Tab. again, with the Diff. of Bearings as a Course, and the Dep. (just found) in Dep. col.; the *Distance* of the object at the time of taking the second Bearing will be found in the Dist. col.

N.B.—If the angle is more than 8 points (or 90°) take its supplement; *i.e.* subtract it from 16 points (or 180°), and enter the Trav. Tab. with this difference as a Course.

Solution of *Ex.* on p. 46:—

Angle between 1st bearing and course, $5\frac{1}{4}$ points. Dist. 21 m., in Dist. col. } In Trav. Tab. give } Dep. 18 in Dep. col.

Diff. of bearings, $6\frac{1}{4}$ points. Dep. 18 in Dep. col. } In Trav. Tab. give } Dist. 19 miles in Dist. col.

Also note the following rule:—

Rule.—By Inspection:—When the angle between the first bearing and the course is 8 points, the distance at either bearing is readily determined *by inspection* from the Traverse Table, thus:—

Enter Trav. Tab. with the Diff. of Bearings as a Course, and the Dist. run in Dep. column; then the Dist. column gives the *Distance* of the object at the time of taking the *last* bearing; and the Lat. column gives the *Distance* of the object when the *first* bearing was taken.

Ex. Cape Clear bore N., and after running W. 7 miles it bore N.E. $\frac{1}{2}$ N.; find the distance at the last observation.

Diff. of bearings, $3\frac{1}{4}$ points. Dist. run 7 m., in Dep. col. } In Trav. Tab. give { Dist. 11 m. D. Lat. $8\frac{1}{2}$ m.

Hence by inspection, the dist. of the Cape was 11 miles from the position *where the second bearing was taken;* also $8\frac{1}{2}$ miles distant when the first bearing was observed.

The learner is requested to make himself thoroughly conversant in working off the ship's place by Dead

Reckoning or Account, by going carefully through the Logs. Nos. I., II., III., and IV. (pp. 35, 43, 45, and 55).

It is a common practice to prick the ship's place on the chart at noon and 8 at night, but this may be done as much oftener as may be convenient.

THE DEVIATION OF THE COMPASS.

You know that the Variation of the compass is the angle between the magnetic and true meridians, caused by the magnetic poles not coinciding with the poles of the earth's rotation; similarly, the Deviation of the compass is the angle, for any special direction of the ship's head, between the direction of the magnetic needle on board and the magnetic meridian. But there is this difference between the Variation and Deviation, that while the Variation is a given quantity of a given name (according to the locality) applicable alike to every point of the compass, the Deviation changes its amount and even its name on different points.

Iron and composite built ships are those in which the compass is chiefly affected by Deviation; it is also found in wood built ships, especially when the compass is placed near huge mechanical steering apparatus, with upright iron stanchions in the vicinity.

Soft iron, without any magnetism of its own, may, under certain conditions, become temporarily a magnet; and hard iron acquires a considerable amount of magnetism either by position or manipulation (as by hammering, bending, &c.), in which case it may have a very powerful effect on the compass needle. The magnetism is acquired during the time the ship is on the stocks; and the effect on the compass is the resultant of the actions of a large number of pieces of iron

hammered and bent into the frame and hull of the ship, and of numerous others that are placed here and there, such that they are now in one position and now in another with regard to the magnetic meridian: thus the magnetism is partly sub-permanent and partly induced or transient, but, more or less, it is always present.

Did you ever take a piece of soft iron two feet long and half an inch in diameter, and raising it vertically, try its effect on the compass?—whatever might be its effect as it lay horizontally, it would, when raised perpendicularly, attract the North-marked end of the needle to its upper end when brought near it, and its lower end would repel the North-marked end of the needle; this arises from the upper end of the vertical bar having acquired, by position, a polarity dissimilar to that of the N-marked end, and its lower extremity (which is directed towards the magnetic pole of the northern hemisphere) a polarity similar to that of the N-marked end; and the attraction and repulsion of the North-marked end of the needle follows the law of magnetism by which unlike poles attract and like poles repel each other. In a similar manner, the North-indicating end of the compass is attracted to that part of the iron ship which was South while on the stocks; and according to the magnetic direction of the ship while building this attraction may be towards the stern, the bow, the starboard side, or the port side, or partly towards an end and a side. It follows that (1), for a ship built head North, the North-marked end of the needle is attracted towards the stern; (2), for a ship built head South the attraction is towards the bow; (3), for a ship built head East the attraction is towards the starboard side; and (4), for a ship built head West the attraction is towards the port side.

From the special magnetic property developed in a ship according to her position when building, for a compass *aft*, in the usual place of the steering compass, the *character* of the Deviation may be approximately represented in a tabular form, thus:—

Approximate Magnetic Direction of Ship's Head while building.	Maximum E. Deviation is found when Ship's Head by Compass is near	Maximum W. Deviation is found when Ship's Head by Compass is near
North.	West.	East.
N.E.	N.W.	S.E.
East.	North.	South.
S.E.	N.E.	S.W.
South.	East.	West.
S.W.	S.E.	N.W.
West.	South.	North.
N.W.	S.W.	N.E.

Or it may be illustrated more practically by giving the deviation on the eight principal points of the compass for eight different ships, each of which was built in a different direction;—the maximum deviation being something under 2 points:—

Ship's Head by the Aft Compass.	Correct Magnetic Direction of Ship's Head while building.							
	North.	N.E.	East.	S.E.	South.	S.W.	West.	N.W.
	Dev.	Dev.	Dev.	Dev.	Dev.	Dev.	Dev.	Dev.
North.	0	12° E.	20° E.	12° E.	0	12° W.	20° W.	12° W.
N.E.	9° W.	5 E.	19 E.	22 E.	19° E.	5 E.	9 W.	12 W.
East.	20 W.	12 W.	0	12 E.	20 E.	12 E.	0	12 W.
S.E.	19 W.	22 W.	19 W.	5 W.	9 E.	12 E.	9 E.	5 W.
South.	0	12 W.	20 W.	12 W.	0	12 E.	20 E.	12 E.
S.W.	19 E.	5 E.	9 W.	12 W.	9 W.	5 E.	19 E.	22 E.
West.	20 E.	12 E.	0	12 W.	20 W.	12 W.	0	12 E.
N.W.	9 E.	12 E.	9 E.	5 W.	19 W.	22 W.	19 W.	5 W.

Besides the Deviation that an iron ship has when on an even beam, it is subject to be altered in character and amount by the vessel's *heeling to starboard or port;*

and the *maximum* heeling errors are found *on northerly and southerly courses, none on east and west courses* (by compass). As for the character of this deviation (E. or W.) in the *northern hemisphere, in the majority of iron ships, the North end of the compass needle is drawn to windward* (*i.e.* to the higher or weather side), when the binnacles are above the upper deck, and the following results would arise from a disregard of this heeling error :—

"If the ship be kept steady on one compass course, she will be found to windward of her supposed position when on northerly courses, and to leeward on southerly courses. If she be steered steadily for a fixed point on the horizon, she will *appear* to fall off as she heels on northerly courses, and to come up on southerly courses." Therefore, as *a general rule*, it should be borne in mind "that in steering by compass and wishing to make a *straight course*, we must keep away, by compass, on either tack, as the ship heels, when on northerly courses; and keep closer to the wind, by compass, on either tack, when on southerly courses."

In the *few cases* in which the *North end of the compass needle is drawn to leeward*, the *rule* above is of course *reversed.*

Ships which have a large heeling error to windward in northern latitudes will probably have a large heeling error to leeward in high southern latitudes.

To allow for Deviation on a Compass Course steered. —As with variation, on a course steered, allow Easterly deviation to the right, Westerly deviation to the left, to get the *correct magnetic course.* For other information, see Rosser's "Deviation of the Compass considered practically."

I now show you a Deviation Card, and will explain its use:—

DEVIATION CARD OF STEERING COMPASS.

YACHT "TIPPETY WITCHET."

1. Ship's Head (Course) by Compass.	2. Deviation.	3. Correct Magnetic Course made good.	1. Ship's Head (Course) by Compass.	2. Deviation.	3. Correct Magnetic Course made good.
North.	14° W.	N. 14° W.	North.	14° W.	N. 14° W.
N. *b* W.	16½ W.	N. 28° W.	N. *b* E.	11 W.	North.
N.N.W.	18½ W.	N. 41° W.	N.N.E.	7½ W.	N. 15° E.
N.W. *b* N.	19 W.	N. 53° W.	N.E. *b* N.	4 W.	N. 30° E.
N.W.	19 W.	N. 64° W.	N.E.	1 W.	N. 44° E.
N.W. *b* W.	17 W.	N. 73° W.	N.E. *b* E.	1½ E.	N. 58° E.
W.N.W.	14½ W.	N. 82° W.	E.N.E.	4 E.	N. 71½° E.
W. *b* N.	11 W.	West.	E. *b* N.	5½ E.	N. 84° E.
West.	7 W.	S. 83° W.	East.	7 E.	S. 83° E.
W. *b* S.	2½ W.	S. 76° W.	E. *b* S.	8 E.	S. 71° E.
W.S.W.	1½ E.	S. 69° W.	E.S.E.	9 E.	S. 58½° E.
S.W. *b* W.	5½ E.	S. 62° W.	S.E. *b* E.	10 E.	S. 46° E.
S.W.	9 E.	S. 54° W.	S.E.	11 E.	S. 34° E.
S.W. *b* S.	11½ E.	S. 45° W.	S.E. *b* S.	12 E.	S. 22° E.
S.S.W.	13 E.	S. 35½° W.	S.S.E.	13 E.	S. 9½° E.
S. *b* W.	14 E.	S. 25° W.	S. *b* E.	13½ E.	S. 2° W.
South.	14 E.	S. 14° W.	South.	14 E.	S. 14° W.

Note.—First observe that the term *correct magnetic* (see col. 3) has chiefly come into use since the introduction of iron ships: it signifies a course or bearing made as if by a compass unaffected by deviation, and influenced only by variation.

Col. 1 gives the various points of the compass, and Col. 2 the Deviation on the different points; as deviation goes the same way as variation, you can understand that if the Dev. with the ship's head N.W. by compass is 19° W., your *correct magnetic course* will be N. 64° W. or about N.W. *b* W. ¾ W.; this would then have to be corrected for the variation to get the *true* course. Similarly, with the ship's head

S.E. *b* E. on which is 10° E. Dev., the correct magnetic course made good would be about S.E., or S. 46° E.

Col. 3 is obtained by applying the Dev. in Col. 2 to the points of the compass in Col. 1; and Col. 3 indicates what course you should steer by compass to make good any required correct magnetic course;—thus, say that the chart shows that you should steer a *correct mag. course* West; you look to Col. 3 and opposite it in Col. 1 is W. *b* N. your steering course. Similarly you wish to steer a *correct mag. course* N.N.E. ¾ E.; you look to Col. 3 and find N. 30° E. (which is about N.N.E. ¾ E.) requires you to steer N.E. *b* N. as indicated by Col. 1.

Remember that whenever you *take a bearing* you *correct it*—not for deviation on the bearing—but *for the deviation due to the Direction of the ship's head*, thus—

Ex. Ship heading N.W. *b* W., a point of land bore by same compass E. *b* S. ½ S. Required the *cor. mag. bearing.*—*Ans.* East; got by applying 17° W., the dev. on N.W. by W. (see card p. 53), to S. 73° E.

Note.—Iron ships, as a rule, lose much of their magnetism in the first two years; but it never wholly disappears.

I now give you a *day's work* with Deviation; apply it, as well as the leeway and variation, as already directed.

Thus, departure course S.E. by S. ¾ S. becomes, when reversed and turned into degrees, N. 25° W., to which apply 15° W. deviation, and 25° W. variation, and the resulting true course is N. 65° W.; N.W. by N. similarly corrected gives N. 74° W.; and so with the other courses: try to get the answer as given at the foot of the table.

LOG-BOARD. No. IV.

H.	K.	T.	Courses.	Winds.	Lee-way.	Dev.	Remarks.
1	6	5	N.W. *b* N.	W.S.W.	0	15°W.	Noon. The Departure is taken from Tory Island in Lat. 55° 16′ N., Long. 8° 15′ W., bearing by compass S.E. *b* S. ¾ S., distant 12 miles; ship heading N.W. *b* N., with deviation 15° W.
2	7	5					
3	8	5					
4	8	5					
5	9	0	N. ½ E.	W.N.W.	¼	3° E.	
6	9	0					
7	8	5					
8	8	5					
9	8	5	W. ¼ S.	N.N.W.	½	23°W.	
10	9	5					
11	9	5					
12	8	5					
1	8	5	N.W. *b* N.	W. *b* S.	¾	15°W.	
2	7	5					
3	8	5					
4	7	5					Variation 25° W.
5	8	0	S.E. *b* S. ¼ S.	S.W.	¼	6° E.	
6	8	5					
7	9	5					
8	9	0					
9	9	0	W. *b* N. ½ N.	S. *b* E.	0	23°W.	Current set ship correct magnetic N.N.E. ¼ E., 18 miles in the 24 hours.
10	10	0					
11	9	5					
12	9	5					

Course.	Dist.	D. Lat.	Dep.	Lat. in.	Long. in.
N.87°W.	104 m.	5·7′ N.	103·4′ W.	55° 22′ N.	11° 17′ W.

COURSE AND DISTANCE BY MERCATOR'S SAILING.

If the places are distant you must compute the Course and Distance by Logarithms as follows:—

For the difference of Latitude.—Both Lats. of the same name, subtract the less from the greater. If Lats. are of different names take their sum. Then multiply the degrees by sixty, and add in the miles. The result is the Diff. Lat. in miles.

For the meridional difference of Latitude.—From Table VI. take out the *meridional parts* for each Lat. If

both Lats. have the same name, take the difference of the Mer. Parts. If Lats. have different names, take the sum of the Mer. Parts. The result is the Mer. Diff. Lat.

For the difference of Longitude.—Both Long. of the same name, subtract the less from the greater. If Long. are of different names, take their sum. The result reduced to miles is the Diff. Long.

Note.—Should the sum of the longitudes exceed 180°, take such sum from 360°; then, this remainder reduced to miles is the Diff. Long.

To find the Course between the two places.—From the Log. (Table I.) of the Diff. Long. (*plus* index 10) subtract the Log. of the Mer. Diff. Lat. The result is the Log. Tangent (Table V.) of the Course, which take out, and *name* N. or S. according to whether the Lat. of the place bound to is N. or S. of the point of departure, and also E. and W. according to whether the Long. of the place bound to is E. or W. of the point of departure.

To find the Distance.—To the Log. Secant (Table V.) of the Course, add the Log. of the Diff. Lat.; the sum (*less* 10 in the index) is the Log. of the Distance, which take from Table I.

Ex. Compute the Course and Distance from the Bishop's Rock, Lat. 49° 52′ N., Long. 6° 26′ W., to the Bermudas, Lat. 32° 26′ N., Long. 64° 37′ W.

From lat. 49° 52′ N. . .	Mer. P. 3462	Long. 6° 26′ W.	
To lat. 32 26′ N. . .	,, 2059	Long. 64 37 W.	
17 26	Mer. D. lat. 1403	58 11	
60		60	
Diff. lat. S. 1046 miles.		Diff. long. W. 3491 miles.	

Diff. long. 3491	Log. (+ 10 to index) 13·542950
Mer. diff. lat. 1403	Log. 3·147058
Course S. 68° 6½′ W.	Tangent 10·395892

Course 68° 6½′	Secant 10·428463
Diff. lat. 1046	Log. 3·019532
Distance 2805 m.	Log. 3·447995 (less 10 in index).

Hence, Course S. 68° 6½′ W. or W.S.W. (westerly), and Distance 2805 miles.

Parallel Sailing by Logarithms.—For short distances and departures the method by *Inspection* is generally near enough, especially if you have interpolated between one degree and its next when using the Traverse Tables; but for long distances you will find Logarithms more accurate.

1. Given the Distance run on a parallel of Lat. to find the Diff. Long.

Rule.—To the log. secant of the Lat. add the log. of the Dist.; the sum (*less* 10 in the index) gives the log. of the Diff. Long., which take out. (*Note.*—This rule is also applicable to Mid. Lat. Sailing, using the mid. lat. for the parallel, and dep. for distance.)

Ex. On the parallel of 50° 28′ the distance run was 498 miles; find the difference of longitude made.

Lat. 50° 28′	Secant 10·196183
Dist. 498	Log. 2·697229
Diff. Long. 782·4′	Log. 2·893412

2. Given the Diff. Long. of two places on the same parallel, to find their Distance along that parallel.

Rule.—To the log. cosine of the Lat. add the log. of the Diff. Longitude; the sum (*less* 10 in the index) is the log. of the Dist., which take out.

Ex. On the parallel of 42° 30′ S. it is intended to run from long. 20° E. to long. 112° E.; required the distance.

112° — 20° = 92° = 5520′ diff. long.

Lat. 42° 30′	Cosine 9·867631
Diff. Long. 5520	Log. 3·741939
Distance 4070	Log. 3·609570

A few final words *on correcting courses sailed and bearings taken*:—

1. Remember that when correcting courses or bearings you must imagine yourself to be standing in the *centre* of the compass, looking in the *direction* of the course or bearing.

2. A *compass* course may be affected by Leeway, Deviation, and Variation.

3. When there is *no Deviation*, the course is *correct magnetic*, but may be affected by Leeway and Variation.

4. A *compass* bearing may be affected by Deviation (due to the direction of the ship's head, *i.e.* her course), and by Variation.

5. A *correct magnetic* bearing is affected only by Variation.

6. To *correct for Leeway*, apply it to the course steered, in a direction *from the wind;* hence, to the right if on the port tack, but to the left if on the starboard tack.

7. To *correct a compass Course for Deviation*, apply Easterly Deviation to the right, and Westerly Deviation to the left, of the course.

8. To *correct a compass course for Variation*, apply Easterly Variation to the right, and Westerly Variation to the left, of the course.

The result of the application of the above corrections is the *true course*.

Note.—Remember that as regards the Variation at any given place, it is of the same amount and name for every course; but each course has its own special Deviation.

Note.—The *Error of the Compass* for any special course is the combined effect of the Variation at the place, and of the Deviation due to that course; hence, it is the sum or difference of the Variation and Devia-

tion, according to whether these have the same or different names.

9. A compass *Bearing*, if it is *correct magnetic*, requires correction only for Variation ; otherwise it must be corrected for Variation, and also for the Deviation due to the direction of the ship's head or course ; in both cases, Easterly to the right, and Westerly to the left ; the result is the *true Bearing*.

10. When a *true* course has been taken from the chart, and has to be converted into a *compass* course, apply—

Easterly Variation to the left, but Westerly Variation to the right.

So also, with regard to Deviation, apply—

Easterly Deviation to the left, but Westerly Deviation to the right.

If there is no Deviation, the *true* course, by the application of the Variation, becomes the *compass* course.

But if *there is Deviation*, the application of the Variation merely converts the *true* into a *correct magnetic* course ; and to the latter must be applied the Deviation due to that particular correct magnetic direction of the ship's head ; which being done the result is the *compass* course.

PART II.

ON FINDING THE LATITUDE AND LONGITUDE BY OBSERVATION.

ALTHOUGH the sextant is a superior instrument to the quadrant, the latter will answer our purpose sufficiently well, if care be taken to purchase a good one from a respectable maker.

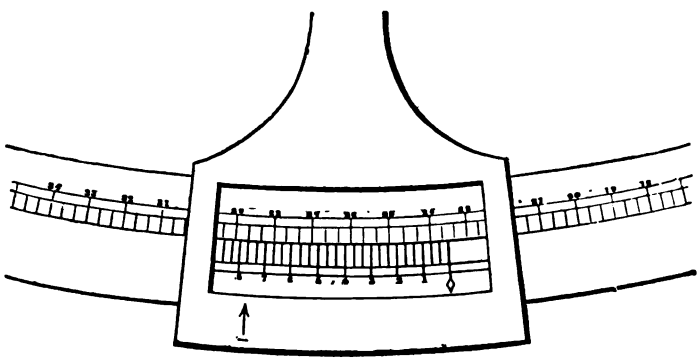
A *quadrant* is a reflecting instrument, in which the arc is divided a few degrees beyond 90°; in the *sextant* the graduations extend a few degrees beyond 120°: the intermediated graduations in the latter instrument are also more minute than those in the former.

For a full explanation of the sextant, the reader is referred to the "Treatises on Mathematical Instruments," Nos. 32 and 170, forming volumes of this series of Rudimentary Works.

To read off the quadrant.—It will be seen that the arc of the instrument is divided into degrees, marked 18, 19, 20, &c. Each of these is again divided into thirds, each therefore representing 20′.

The vernier scale is that which is movable. As the arc is divided into degrees and minutes, so is the vernier scale divided into minutes and seconds only. The nonius on it is marked thus . To ascertain the amount of degrees, minutes, and seconds denoted by the instrument, observe what line of the vernier

scale coincides with a line on the arc of the instrument. The engraved arrow is in this instance inserted to point out to the learner the coinciding lines. The nonius is somewhere between 23° and 24°; that is, it points out 23° 20′ at the least: for the excess or remainder we must now look at the vernier scale below. Here the coinciding line is the second division between 7′ and 8′. Here, then, 7′ 40″ are to be added to the



quantity previously read off on the arc, that is, to 23° 20′, the sum now being 23° 27′ 40″.

ADJUSTMENTS OF THE QUADRANT AND SEXTANT.

1. The first adjustment is to set the index glass perpendicular to the plane of the instrument.

To make that adjustment, place the vernier near the middle of the arc and look obliquely into the index glass to see if the arc and its image are continuous; if they are not, slacken or tighten (as required) the proper screws.

2. The second adjustment is to set the horizon glass perpendicular to the plane of the instrument.

Set O on the vernier to O on the arc; then hold the instrument obliquely, and look from the sight vane through the horizon glass to the horizon; if the horizon and its image form one line, the glass is perpendicular; if not, make it so by the screw for that purpose.

3. The third adjustment is to set the horizon glass parallel to the index glass, with O on the vernier set to O on the arc.

To make the third adjustment, hold the instrument vertically, and look from the sight vane through the horizon glass to the horizon: if the horizon and its image form one line the horizon glass is parallel to the index glass; if not, make it so by the screw for that purpose.

4. In the absence of a screw or screws, find the index error by the horizon, as follows:—Set O on the vernier to O on the arc, hold the instrument vertically, and look at the horizon through the horizon glass; if the horizon and its image are not in one line, move the tangent screw till they are so; the reading is the error, which is to be added if the reading is off the arc, to be subtracted if on the arc.

5. Or you may find the index error by the sun as follows:—Turn on the shades adapted to your sight, hold the instrument vertically, the index being near 30′ on the arc; then look at the sun and move the index till the edges of the sun and its image just touch; take this reading, which is *on* the arc. Then place the index near 30′ off the arc, and again make the edges of the sun and its image touch; take this reading, which is *off* the arc. Half the difference of the two readings is the index error, to be added if the greater reading is off the arc, to be subtracted if the greater reading is on

Ex. Reading off the arc 33′, reading on the arc 29′; half the difference is 2′ to be added.

To know whether those measurements or angles have been taken with tolerable accuracy, the sum of the two readings, divided by 4, should be the sun's semi-diameter for the day as given in the Nautical Almanac.

Our next step must be to know how to convert longitude into time, and *vice versâ*, both which operations are constantly in use in finding latitude and longitude.

RELATION OF DEGREES (OR ARC) TO TIME.

The earth rotates on its axis once in 24 hours, and its circumference is 360 degrees; hence, if we divide the degrees by the hours (360 by 24) we have the following *relation of arc* (or longitude) *to time*, viz. 15° for 1h., 15′ for 1m., and 15″ for 1 sec., whence—

1° will correspond to 4 m. (*i.e.* the 15th part of 1 hour or 60 m.).
1′ „ „ 4 s. (*i.e.* the 15th part of 1 minute or 60 s.).
1″ „ „ 4 thirds (*i.e.* one-sixtieth of a second).

and the following rules are sufficiently clear.

To convert Degrees, &c., of Longitude into Time.

Rule.—Multiply by 4; then the degrees of Long. become minutes of time; the minutes (′) of Long. become seconds of time; and the seconds (″) of Long. become thirds of time.

Ex. Convert 9° 42′ of longitude into time.

Long. (in arc)	9°	42′	
		4	
Long. in time	38m.	48s.	

Ex. Express 94° 54′ 30″ of longitude in time.

Long. (in arc)	94°	54′	30″
			4
Long. in time	6h.	19m.	38s. 0

Similarly 18° 54′=1h. 15m. 36s.; and 100° 14′=6h. 40m. 56s.

Or, the conversion can be made by Table XII., but not so readily.

To convert Time into Degrees of Longitude (or Arc).

Rule.—Express the hours and minutes as minutes only, and divide by 4; then, the minutes of time become degrees; the seconds of time become minutes (′) of arc, &c.

Ex. Express 6h. 4m. 20s. in degrees, ′ and ″.

6h. 4m. 20s.
60

4)364m. 20s.

91° 5′

Ex. Convert 8h. 40m. 38s. into degrees, ′ and ″.

8h. 40m. 38s.
60

4)520 38

130° 9′ 30″

Similarly, 20m. 49s.=5° 12′ 15″; and 10h. 15m. 42s.=153° 55′ 30″.

Time may also be converted into arc by multiplying by 15, or its equivalent, 3 times 5; when seconds of time become ″ of arc, minutes of time ′ of arc, and hours become degrees. Thus—

8h. 40m. 38s.
3

26 1 54
5

130° 9′ 30″

Or the conversion may be made by Table XII.

We are now in a position to understand (1) the relation of civil to astronomical time; and (2) the relation of ship time and longitude to the Greenwich Date.

TO CONVERT CIVIL TIME INTO ASTRONOMICAL TIME.

If the civil time is P.M. (*after noon*), meaning hours between noon and midnight, it corresponds to the astronomical time; thus—

April 8th, at 7h. 26m. P.M. (civil time),
is April 8d. 7h. 26m. (astronomical time).

If the civil time is A.M. (*before noon*), meaning hours between midnight and noon, add 12h. to the civil time, and put the date 1 day back; thus—

April 8th, at 7h. 26m. A.M. (civil time),
is April 7d. 19h. 26m. (astronomical time).
Also, November 1st, at 10h. 46m. A.M. (civil time),
is October 31d. 22h. 46m. (astronomical time).

THE TIME AT SHIP AND LONGITUDE BEING GIVEN, TO FIND THE GREENWICH DATE.

1. Express the ship date as astronomical time.
2. Convert the longitude into time, and place it under the ship time.
3. If the longitude is West, add it to the ship time. (*Note.*—If the sum of the hours is more than 24h., reject 24h. and add 1 day to the date.)
4. If the longitude is East, subtract it from the ship time. (*Note.*—If the hours of longitude exceed the hours at ship, add (mentally) 24h. to the ship time, and put the date 1 day back.)

Ship time May 18d.	4h. 10m.
Long. 49° 30′ W.	3 18
Green. date, May 18d.	7 28

Ship time, May 18d. .	8h. 7m. A.M.	
„ May 17 . .	20 7	(astronomical time)
Long. 125° 30′ W. . .	8 22	
Green. date, May 18d. .	4 29	

Ship time, July 3d. .	9h. 40m.	Ship time, July 17d. .	4h. 32m.
Long. 64° 15′ E. . .	4 17	Long. 142° 30′ E. . .	9 30
Green. date, July 3d. .	5 23	Green. date, July 6d.	19 2

TO FIND OUR LATITUDE.

This is to find our distance from the equator. That point of the heavens which is immediately over our heads is termed the zenith; and at some spot between the tropics the sun at noon is immediately or nearly overhead; but as we move farther North or South, it becomes more distant from our zenith; so that when we know what this distance may be, the sun's distance from the equator, we at once know *our* distance from the equator, that is, our latitude. To ascertain the Zenith Distance, we thus proceed. If two imaginary lines are drawn from our feet, one to our zenith, the other to the horizon, they will be at right angles to each other, that is, the two lines at their junction will form an angle of 90°. If, again, we imagine a third line to be drawn from our feet to the sun's centre, and are enabled to learn the number of degrees contained between this last line and the one drawn towards the horizon (which the quadrant or sextant will do for us), when we subtract these degrees from 90°, the remainder will be the number of degrees contained between the imaginary lines from our feet to the sun and from our feet to the zenith; or, in other words, the number of degrees the sun may be from the zenith. Thus, suppose the number of degrees contained by the lines from our feet, one to the sun and the other to the horizon, to be 30, then this number being subtracted from 90°, will leave 60° to be contained by the lines from our feet to the sun and zenith respectively; that is, the sun's zenith distance is 60°.

The number of degrees contained by the lines from our feet, one to the sun and the other to the horizon, denote the sun's altitude above the horizon. We now set about to find out the amount of this angle, or the

sun's altitude; subtract it from 90°, and the zenith d
tance becomes known.
The Sun's Declination is the distance of the sun fr
the equinoctial line, which is an imaginary line in t
heavens coincident in space with the earth's equat
therefore, when we know the distance of our zeni
from the sun, and that of the sun from the equinoct
line, as this last is exactly over the equator, we kn
our distance from it, or our latitude.
During our summer, the sun is to the north of t
equinoctial line, and in the winter to the south of
This is termed its North or South Declination, a
tables are computed which give us the amount of t
distance or declination for every day and hour throug
out the year.

To correct the ***Sun's*** *Declination for finding Latitude the Meridian* ***Altitude.***——In the Nautical Almanac t
sun's declination at noon is put down, but only for t
meridian of Greenwich Observatory; therefore at a
place considerably to the east or west of this meridia
allowance must be made for this difference of longitu
On taking out the sun's declination from the Nautic
Almanac, note whether the declination is North
South, increasing or decreasing; thus—August 2
1882. Sun's Declⁿ. 10° 22′ 16″ N. decreasing—Long
tude in 92°. Turn to Table XXIX., and enter it
directed in the explanation, and 5′ 30″ is the correcti
to be added or subtracted, for the difference of longitu
as directed.
But by the side of the Declination in the Naut. Al
you will see a column headed "Var. in one hour;" th
is the hourly change of the declination, which, if mu
tiplied by the Long. in time, must give us the requir
declination for the position; hence—

Rule.—From Naut. Alm., p. I., of month, take out the Declination for the Ship Date, and also the "Var. in 1 h." for the same date. Multiply the "Var. in 1 h." by the Longitude in Time, and the product will be the *correction*, to be applied as follows:—

In W. long. { Dec. increasing, add correction.
Dec. decreasing, subtract correction.

In E. long. { Dec. increasing, subtract correction.
Dec. decreasing, add correction.

Ex. August 26th, 1882: Long. 92° E.

92°	Var. 52″·25
4	6·1
6h. 8m.	5225
	31350
	6,0) 31,8·725
	Cor. + 5 18·7
	10 22 15·6
	Red. Dec. 10 27 34·2 N.

Ex. Same date: Long. 36° W.

36°	Var. 52″·25
4	2·4
2h. 24m.	20900
	10450
	6,0) 12,5·400
	Cor. — 2 5·4
	10 22 15·6
	Red. Dec. 10 20 10·2 N.

Note.—The Dec. is corrected to the *nearest* tenth of an hour; thus 8 m. is taken as ·1, and 24 m. is of course ·4 of the hour.

This is the best method of getting the declination, and the result is called the Reduced Declination. Such is the first step in finding our Latitude from a Meridian Altitude, or from the sun's altitude at noon.

As soon as we have ascertained, by means of the quadrant, the Altitude, we have several modifications to apply to it: it is termed the Observed Altitude, in contradistinction to the True Altitude of the sun's centre above the horizon.

We take the altitude of the sun's lower limb because it can be brought apparently to touch the horizon to great accuracy; whereas if we were to place the sun's centre in junction with the horizon, this centre would have to be guessed at.

Sun's observed altitude and its corrections.—The of the sun's lower limb above the horizon hav-

ing been taken by means of a quadrant or sextant, the following corrections must be applied to it, and in the order given :—

1. That due to the instrument, and which is called the *Index Error*, may be additive or subtractive, as already explained on p. 62.

2. *Subtract* the *Dip* due to the height of the eye above the sensible horizon ; this correction comes from Table VIII., which is entered with the *height of the eye* of the observer above the sea level, opposite to which is the *dip ;* thus 15 feet gives 3′ 49″ to subtract.

3. *Subtract* the *Refraction* in Altitude, since the bending of the rays of light due to passing through an atmosphere of increasing density causes an object to appear at a greater altitude than it really has; this correction comes from Table XV., thus *App. Alt.* 43° 10′ gives refraction 1′ 2″ to subtract.

4. From Naut. Alm., p. II., of the month, take out the sun's semi-diameter: *add* this to the alt. of the lower limb to get the alt. of the centre.

5. *Add* the *Parallax* in Alt. taken from Table XIV., under 9 at the top, since the sun's Hor. Par. is just less than 9″; enter Tab. with App. Alt. ; thus App. Alt. 42° gives 7″ to add.

Par. in Alt. is the correction that gives the object the Alt. it would have if it were seen from the earth's centre: that for the sun is small and *might be neglected*, but that of the moon is very considerable.

LATITUDE BY MERIDIAN ALTITUDE OF SUN.

It may be as well now to collect together the substance of what has been said about finding the latitude by a meridian altitude of the sun.

1. *Correct the Sun's Declination* for the Longitude (see p. 68), always taking the Dec. from Naut. Alm., p. I. of the given month.

2. *For the True Altitude.*—Correct the *observed* Altitude for Index Error (if any), Dip, Refraction, Semi-diameter, and Parallax (see p. 69). The result will be the True Alt.

3. *For the Zenith Distance.*—Subtract the True Altitude from 90°; and name the remainder N. when sun bears S., but S. when sun bears N.

4. *For the Latitude.*—Under the Zen. Dist. write the reduced Declination, each having its proper name N. or S.; if both are N., or both S., take their sum for the Latitude; if one is N. and the other S. take their difference for the Latitude, of the same name as the greater. If Zen. Dist. is 0, the Declination is the Latitude; if Declination is 0, the Zen. Dist. is the Latitude.

The following is an example in full, by which all future similar observations may be solved:—

Example. August 26, 1882. Long. 92° E. Observed meridian Altitude of sun's lower limb, 56° 42′ 10″ bearing N. Eye 18 feet. Index Error 1′ 32″ to be subtracted. What is the latitude in?

Long. 92° = 6h. 8m. = 6·1h.

Then 52″·25 × 6·1 = 318″·725 = 5′ 18″·7 correction of Dec. to be added because Long. is E. and Dec. decreasing.

Sun's declination	. .	10° 22′ 15″ N. (page I. Naut. Alm.)
Correction for longitude	.	+ 5 19
Reduced declination	. .	10 27 34 N.

Observed altitude	56°	42′	10″ N.
Index error	—	1	32
	56	40	38
Dip (T. VIII.)	—	4	11
	56	36	27
Refraction (T. XV.)—Par.		—	33
	56	35	54
Sun's semi-diameter	+	15	52 (page II. Naut. Alm.)
True alt.	56	51	46 N.
	90		
Zenith distance	33	8	14 S.
Reduced declination	10	27	34 N.
Latitude in	22	40	40 S.

Here the zenith distance being S., and the declination N. (of different names), we take their difference, and the latitude in is S., of the same name as the greater; had both been S., or both N., we would have taken their sum for the latitude in. On the North side of the equator the sum or remainder must, of course, be always in north latitude.

Ex. 1882; January 20th; long. 35° 40′ W.; observed meridian altitude of sun's lower limb 26° 10′ bearing south; height of eye 16 ft; index error 1′ 40″ to add. Required the latitude in.

Ans. 43° 34′ 33″ N.

Ex. 1882; March 20th; longitude 91° W.; observed meridian altitude of sun's lower limb 66° 0′ 40″ bearing south; eye 19 feet; index error 2′ 50″ to subtract. Required the latitude in.

Ans. 23° 51′ 53″ N.

Ex. 1882; June 14th; long. 21° W.; observed meridian altitude of sun's lower limb 51° 1′ 40″ bearing south; eye 15 feet. Required the latitude in.

Ans. 62° 4′ 7″ N.

Ex. 1882; August 25th; long. 42° 1′ W.; observed meridian altitude of sun's lower limb 49° 51′ 30″ south of observer; eye 17 feet. Required the latitude.

Ans. 50° 38′ 5″ N.

Ex. 1882; October 20th; long. 30° 1′ E.; observed meridian altitude of sun's lower limb 45° 50′ bearing south; eye 17 feet. Required the latitude in.

Ans. 33° 36′ 5″ N.

Ex. 1882; September 23rd; long. 60° 10′ E.; observed meridian altitude of sun's lower limb 55° 1′ bearing north; eye 20 feet. Required the latitude in.

Ans. 34° 52′ 9″ S.

Note.—In order to take the sun's altitude when greatest, continue, by means of the tangent screw, to bring the lower limb of the sun down to the horizon, so long as the sun is on the ascendant. Persevere in doing this until the imaged sun ceases to rise above the horizon; persist in bringing it down to the horizon, but never up to it. *The instrument should be vibrated so that the image may skim the horizon, for the altitude must be measured to the point vertically below the sun.*

Should the learner be on land, and desirous of becoming conversant with the use of the quadrant, and perfect in the preceding operation, he should furnish himself with the *Artificial Horizon*, by which means he will, on going to sea, be better prepared than if he had never taken an observation. He must remember that the Artificial Horizon will, from its structure, give double the sun's observed altitude; and, therefore, after reading off the number of degrees indicated on the limb of the quadrant, he must first add or subtract the index error, and then halve the remainder for the observed altitude of the sun.

Assuming that the learner has attentively studied his subject, and mastered the contents of the preceding pages, he should be competent to find his latitude in any part of the globe. Should he, however, still further pursue his studies, with the view of becoming capable of finding his longitude by means of the quadrant and chronometer, he will thus acquire great

advantages while roaming the ocean, where he may chance to be several successive days without a sight of the land, and when, after such an interval, his longitude by Account or Dead Reckoning might prove to be seriously wide of the truth. In addition to this, his being enabled to ascertain the mean time either at sea or on land, which is included in the operation of finding the longitude, cannot be deemed superfluous.

Knowing the latitude and longitude there will be no occasion to get into the latitude of the port bound for, and then to sail along that parallel, as you must do if you know only the latitude.

ON FINDING THE LONGITUDE.

The appearances of sunrise, noon, and sunset, it is needless to observe, are occasioned by the rotation of the earth on its axis; and when the sun is just rising to the inhabitants of London, it will not do so to those of Pembroke until a number of minutes later—while it had risen to the people of Antwerp previously—in each case in proportion to their longitude east or west of London. Knowing the rate at which the earth thus rotates (900 miles in an hour), if we also know when it is noon at London and when at Pembroke, we can ascertain the difference of longitude between the two places: thus of two clocks, one set to London time and the other to Pembroke time, when the London clock showed noon, or 12h., the Pembroke clock would show 19m. 48s. to 12, indicating that Pembroke was 4° 57′ W. of London.

By means of our quadrant we are enabled to find the true time at Pembroke or at any other spot on which we may be: but we are not able to know our meridian distance east or west from Greenwich, unless we also

know the time there at the same instant. This the chronometer will furnish us with, as it was set to the Greenwich mean time. Therefore, if at Pembroke we take an observation of the sun at 8 in the forenoon, and the chronometer showed 19m. 48s. past 8, we arrive at the same result as above.

To ascertain the time at sea, with the view of finding the longitude, we must know—

1. The sun's altitude.
2. The mean time at Greenwich when the altitude was taken.
3. The equation of time reduced to the moment of observation.
4. The sun's reduced declination, and thence the polar distance.

From the above data we find the sun's hour-angle, and the time at sea; then the difference between the time at sea and that at Greenwich gives the longitude.

In addition to the chronometer on board, which must not be moved from its situation, nor its hands altered, it is assumed that the navigator is furnished with a good watch; but attention must be first directed to the chronometer. No chronometer is known to keep true mean time, or can be made to do so: human skill is not sufficiently perfect to accomplish this, though it can produce chronometers which will answer our purpose equally as well by going at a uniform rate, so that they shall respectively be ever gaining or losing the same quantity of time during a day. Knowing, then, this quantity, we have only to subtract or add it, as the time-keeper gains or loses, and we have the true mean time. This is termed *correcting the chronometer for rate.* We must also correct it for error, which is the quantity of time it was too fast or slow for mean time when it was brought away from Greenwich; for

the express purpose of the chronometer is to show us the mean time at Greenwich, for which spot all the astronomical *data* in the Nautical Almanac are calculated.

To correct the chronometer for rate and error, multiply the rate by the number of days and parts of a day since the chronometer was last rated, and reduce the product into minutes, if required, and you have the *accumulated rate*, which is to be added to the chronometer time when the observation was taken, if it be losing, or subtracted, if gaining. Add also its original error, if it was slow, or subtract it, if it was fast; and the result will be the mean time at Greenwich.

In ascertaining the accumulated rate, which is the chronometer's gain or loss in twenty-four hours, the portions of the day of observation which have elapsed must also be taken into consideration; but this difference is so minute, that an approximation to it is sufficient. Thus, suppose the daily loss of the chronometer to be 4s., and the observation to be made at 21 hours from the preceding noon, when of course 2s. must be allowed for loss during 12 hours, and 1s. may be allowed for the rest of the elapsed time; and, therefore, 3s. more must be added to the accumulated rate for the entire days.

You can understand that if, for a given place on a given day, you were told that your watch was 1m. 29s. slow, and gaining 3s. daily, five days afterwards it would only be 1m. 14s. slow, that is 1m. 29s. *less* 15s.; and if the watch indicated 2h. 30m. 40s. P.M., the correct time would be 2h. 31m. 54s. P.M.

We will take another example.

Example. May 1st the chronometer was 2m. 10s. too slow for Greenwich mean time, and gaining 2·4s. daily. Required the Greenwich mean time by the same chronometer on June 2nd, when it showed 4h. 36m. 25s.

Daily rate	2·4s.	
From May 1 to June 2 .	=32 days.	
	48	
Gain for 4½ hours 0	72	
	6,0) 7,6·8	
Accumulated rate . .	1 17	gain.
Chronometer time .	4h. 36 25	
	4 35 8	
Original error . .	0 2 10	too slow.
Mean time at Greenwich	4 37 18	

Ex. On August 7th the chronometer indicated 8h. 0m. 52s.; it had been found 1m. 55s. fast on Greenwich mean time, on March 1st and losing 3·4s. daily. Required the true M. T. at Greenwich.—*Ans.* 8h. 7m. 58·7s.

Instead of taking one altitude of the sun, and the time at which it was taken, it is far preferable to take four or five, or even seven observations in succession, noting down their corresponding times, and to take the mean of the altitudes and times, which is done by adding them together, and dividing the sums by the number of observations taken.

When the mean of the times is put down, if you have used a hack watch, and thus taken the altitudes and times yourself, mark how much the watch is slower or faster than the chronometer; and applying the difference to the mean of the times, we have the chronometer time, which, being corrected for rate and error, gives us the Greenwich mean time at the instant of observation.

	Altitudes. ° ′ ″		Times. h. m. s.	
	10 7 0		9 23 3	
	10 17 0		23 46	
	10 32 0		25 14	
	10 54 0		26 32	
	11 14 0		27 50	
5)	53 4 0	5)	126 25	
Mean of alts.	10 36 48		9 25 17	mean of times by watch.
Index error	+1 30		+5 34	watch slower than chron.
	10 38 18		9 30 51	chronometer time.

To know when to add 12 *hours to the time shown by chronometer.*—The chronometer only ranges from 0 to 12 hours, but as you already understand (from p. 64) the relation of civil to astronomical time, and that all hours between midnight and the following noon must range between 12 and 24, consequently you may well suppose that if you are taking an observation in the North Atlantic, between 8 and 9 A.M. on the 7th, at a spot about 30° W. of Greenwich, as the ship time is morning, and 20 to 21 hours on the 6th, so it will be morning at Greenwich and between 22 and 23 hours. But for any given spot it may be morning with you, and evening at Greenwich, or evening with you and morning at Greenwich: clearly to understand this, and also when you are to add 12 to the chronometer hours, you must know (*approximately*) two things, viz., the time at ship and your longitude, and use these to get an *approximate* Greenwich date (see p. 65).

Ex. June 10th, at about 8h. 29m. A.M., in long. 32° W., the chronometer showed 10h. 21m. 30s. What is the Greenwich date?

Ship time June .	9d. 20h. 29m.	Consequently the Gr. date by chron. is 9d. 22h. 21m. 30s.
Long. in time .	2 8	
Approx. Gr. date .	9d. 22 37	

Ex. August 4th, at about 3h. 42m. P.M. at ship, in long. 64° W., the chronometer showed 8h. 0m. 40s. What is the Greenwich date?

Ship time August	4d.	3h.	42m.
Long. in time		4	16
Approx. Gr. date	4d.	7	58

Consequently the Gr. date by chron. is 4d. 8h. 0m. 40s.

Ex. May 10th at 8h. 30m. A.M. at ship, in long. 55° E., the chronometer showed 4h. 47m. 3s. What is the Greenwich date?

Ship time May	9d.	20h.	30m.
Long. in time		3	40
Approx. Gr. date	9d.	16	50

Consequently the Gr. date by chron. is 9d. 16h. 47m. 3s.

Ex. June 17th at 3h. 40m. P.M. at ship, in long. 98° E., the chronometer showed 9h. 7m. 42s. What is the Greenwich date?

Ship time June	17d.	3h.	40m.
Long. in time		6	32
Approx. Gr. date	16d.	21	8

Consequently the Gr. date by chron. is 16d. 21h. 7m. 42s.

These examples, if you look through them carefully, show that the approximate time at ship and long. by account give you an approximate Greenwich date, and at once indicate to you whether your day is the same as that at Greenwich, and also whether you must add 12 hours to the chronometer time to get the correct Greenwich date and time.

Taking the Times of the Altitudes.—If it is the hack watch you use, hold your watch, which should be furnished with a seconds-hand, in the palm of either hand, as may be convenient, or at all events placed where the eye of the observer may fall on it, as soon after he has made the observation as possible. To have this time very accurately, let him set about the observation at the instant the minute-hand is on a minute of the dial; at the same instant he must observe at what number of seconds the seconds-hand is,—then make the

observation, and see to what point the seconds-hand has reached ; when, of course, the time of that altitude will be the number of minutes, *plus* the seconds travelled over by the seconds-hand. Should this last have made more than one entire revolution while the observer was occupied in the observation, he will easily be conscious of it, and take it into the account.

Or, if convenient, you can employ another person to read the chronometer while you take the altitudes; you prepare,—he at the chronometer and you at the side of the vessel to observe ; when ready, you say "look out," as a caution; *immediately* that you have taken the altitude you say "stop" ; at that moment the chronometer is read, and then noted down on paper by the side of the altitude which you also give; and so on through 3, 5, or 7 observations ; but both observer and chronometer-reader must be sharp and instantaneous in what they do.

To correct the Sun's Declination.—For the chronometer time, take the declination from p. II. of the Naut. Alm., entering for the given month and day; also take "Var. in 1 h." from p. I. for same date; multiply the "Var. in 1 h." by the Green. time (*i.e.* by the hours, with the minutes converted into *tenths* of an hour) ; mark off from the right of the product as many decimal places as there are decimals in the "Var." and Green. time together. The number to the left of the decimal point will be *seconds*, which must be divided by 60 (if more than 60) to convert into *minutes* and *seconds ;* this is the *correction* of Declination.

Rule to apply the correction :—

Declination *increasing*, *add* correction to Declination.

Declination *decreasing*, *subtract* correction from Declination.

But *note*, the correction is *subtractive* on the day in March when Declination changes from S. to N., also on the day in September when Declination changes from N. to S.; at either date, *if correction is greater than Declination, subtract the Declination from the correction;* then, in March the remainder will be the Dec. N., but in September the remainder will be the Dec. S.

But the *Declination* will always be *more accurate* when *corrected from the noon nearest* to the Green. time. In this case, when the hours of Green. date are less than 12, the METHOD already given on p. 79 applies in every respect.

But when the hours of Green. date exceed 12, subtract the time from 24 hours; take out the Dec. as well as the Var. in 1 h. for the noon in advance of the Green. date; multiply this "Var. in 1 h." by the time short of 24 hours, and the product will be the *correction;* thus, if the time is 8d. 18h. 42m., this is 5h. 18m. from the next noon, or noon of the 9th; hence take the Dec. and "Var. in 1 h." for the 9th; and multiply the Var. by 5·3 for the correction of the Dec. of the 9th: then—

If Dec. is increasing, subtract correction.

If Dec. is decreasing, add correction.

To correct the Equation of Time.—For the given day take the Equation from Naut. Alm. p. II. of month; also, take "Var. in 1 h." for same day from p. I. of month; multiply the "Var. in 1 h." by the hours and tenths of Green. time, mark off as many decimal places in the product as there are decimal places in the "Var." and time together. This is the *correction* of Equation—

To be *added* if Equation is *increasing;*

To be *subtracted* if Equation is *decreasing.*

Also, take special notice, on p. I. of Naut. Alm. of

the day, when the Equation changes; in the column it is marked by a strong dash ——, and at top thus $\frac{\text{add.}}{\text{sub.}}$ or $\frac{\text{sub.}}{\text{add.}}$

For the Apparent Time at Ship.—Add together the true Altitude, the Latitude of the place, and the Polar Distance of the object; divide the sum by 2, for the Half-sum; and subtract the Altitude from the Half-sum, which call Remainder.

Then, add together the Log. Secant of the Latitude, the Log. Cosecant of the Polar Distance (take Secant of Declination if Pol. Dist. is greater than 90°), the Log. Cosine of the Half-sum, and the Log. Sine of the Remainder. The sum of these four Logs. (rejecting *index* 30) will be the Log. of the Hour-angle, that is, the *time from the nearest noon*, which take out in hours, minutes, and seconds.

N.B.—All Logs. should be taken out to seconds of arc, when the sum of the three arcs exceeds 165°, otherwise the seconds may be rejected. The Logs. used are—first Table V., and then Table XVIII. for the Horary Angle.

	°	′		
True alt.	24	53		Tab. V.
Lat.	54	57	. .	Sec. 10·240868
Pol. dist.	69	50	. .	Cosec. 10·027476
Sum	149	40		
Half-sum	74	50	. .	Cos. 9·417684
Rem.	49	57	. .	Sine 9·883936
Hour-angle	5h.	0m.	26s.	Log. 9·569964

Proceed as follows when using the seconds of arc :—

	°	′	″		
True alt.	13	18	30		Tab. V.
Lat.	45	2	0	. . Sec.	10·150768
Pol. dist.	112	40	20	. Cosec.	10·034927
Sum	171	0	50		
Half-sum	85	30	25	. . Cos.	8·893975
Rem.	72	11	55	. . Sine	9·978693
Hour-angle	2h.	38m.	8·5s.	Log.	9·058363

This, computed to the nearest minute of arc only, gives 2h. 38m. 16s., which would cause an error of 2′ in the longitude.

I wish you to look at these Hour-angles very carefully, and to remember that the resolution of the spherical triangle determines merely *the meridian distance* (in time) *of the sun from the nearest noon.* Hence, with regard to the first, if we suppose the Ship Date to be July 23rd, P.M., we get for the Apparent Time at Ship, July 23d. 5h. 0m. 26s. : but if the Ship Date be July 23rd A.M., then the Hour-angle must be subtracted from 24 hours, and the date put 1 day back, as in the following example,—the reckoning being in astronomical time.

Hour-angle . .	5h.	0m.	26s.
	24		
Apparent time, July 22d.	18	59	34

Similarly with the second Hour-angle, if we suppose the Ship Date to be October 17th, P.M., our Apparent Time at Ship is October 17d. 2h. 38m. 8s.; but for October 17th, A.M., our Apparent Time at Ship is October 16d. 21h. 21m. 52s.

It will be observed that in the calculation for finding longitude, our latitude is used, so that if our lati-

tude is erroneous, so will our longitude be. The best time for making the observation is when the sun is on the *prime vertical, i.e.* true East or West, because an error in the latitude then produces the least effect on the hour-angle; but you can only take an altitude in this position when the latitude and declination have the same name. When these are of different names, the sun never comes to the prime vertical, and in that case you should take the altitude as early as convenient and as far from the meridian as possible; an object observed near the meridian never gives a good hour-angle.

It is far more general to make the observation in the forenoon in preference to the afternoon, for in the latter case the sea, being more or less affected by the day's sun, the refraction of the atmosphere is more precarious than it is in the forenoon.

Should you be doubtful about your latitude, having taken the altitudes and their corresponding times, you can wait until you have found your latitude at noon, carefully keeping the Dead Reckoning during the interval; so that working it back you arrive at the true latitude you were in when you took your altitudes for the time. Work these out for your longitude at that moment, and, allowing for the difference of longitude since made, prick the ship's place at noon.

Should the forenoon be too cloudy for an observation, it is customary to make it in the afternoon, but with favourable weather it would be advisable to work out the longitude at both forenoon and afternoon. Remember that when an afternoon observation is made, there is to be no subtracting from 24 hours; for we only learn the time elapsed since the preceding noon.

Latitude and Longitude by Observation is preferable to Dead Reckoning; but you should lose no opportunity of checking the chronometer while in harbour, or wh-

passing well-known headlands, when the longitude is exactly known; work out the time for the longitude, and observe whether it properly coincides with the truth. Do this every day on which it may be practicable, and be guided accordingly, in your estimate of the Longitude by Observation.

Having now (pp. 73 to 82) given in detail all the different parts of the problem, we may briefly summarise the rule for finding—

LONGITUDE BY CHRONOMETER AND SUN'S ALTITUDE.

1. *For the Greenwich Date, Mean time.*—To the *approximate* Green. Date by chronometer apply the original error and Accumulated Rate (see p. 75).

2. *For the Declination.*—Take the Declination from the Naut. Alm. p. II. of given month, and correct it for the Green. Date, mean time (see pp. 79, 80).

3. *For the Polar Distance.*—Subtract the corrected Dec. from 90° when Lat. and Dec. are both N., or both S.; if Lat. and Dec. are one N. and the other S., add 90° to the Dec. For Lat. 0, subtract Dec. from 90°.

4. *For the True Altitude,* correct the observed Altitude for Index Error, Dip, Refraction, Semi-diameter, and Parallax (see pp. 68, 69).

5. *For the Equation of Time.*—Take the Equation from Naut. Alm. p. II. of month, and correct it for the Green. Date, mean time (see p. 80).

6. With the true Alt., Lat., and Pol. Dist., work out *the Hour-angle* (see p. 81), then—

If A.M. at ship subtract the hour-angle from 24 hours, and before the remainder write the Ship Date, which will be 1 day less than the civil date; but—

If P.M. at ship, the hour-angle is the correct time, before which write the Ship Date unaltered:—

And in either case *you have the Ship Date, Apparent Time.*

7. *For the Mean Time at Ship.*—Under the App. Time at Ship write the Equation of Time, which is to be added or subtracted as directed in Naut. Alm. p. I. of given month. The result will be the Mean Time at Ship.

8. *For the Longitude.*—Under the Ship Date, Mean Time, write the Greenwich Date, Mean Time; take the less from the greater, *remembering that the value of the days in each must be considered as well as the hours.* The remainder will be the Longitude in time, which turn into . . ° . . ′ . . ″ and name—

East if Green. Mean Time is less than Ship Mean Time;—
West if Green. Mean Time is greater than Ship Mean Time.

I will now give two examples to show the solution in full:—

Ex. 1882, May 17th at about 4h. 49m. P.M. in lat. 50° 50′ N., long. by D. R. 25° W.; the observed altitude of sun's lower limb was 25° 20′; eye 17 feet. Time by chronometer 6h. 30m. 45s., which had been found 1m. 40s. fast on Mean Time at Greenwich on April 26th, and losing 3·2s. daily. Required the true Longitude.

Ship date May .	17d. 4h. 49m.	Time by chron. .	6h. 30m. 45s.
D. R. Long. W. . . .	1 40	Orig. err. fast . .	— 1 40
Approx. Green. date	17d. 6 29		6 29 5
		losing	+ 1 8
		By Chron. Green. date	M.T. May 17d. 6h. 30m. 13s.

Rate 3·2s.
April 26 to May 17 = 21

32
64

67·2
For 6h. = ·8

6,0) 6,8

1m. 8s.

17th Decl. (N. A. p. II.)	19°	22′	5″	N.	Eq. T. (N. A. p. II.)	3m.	50s.·36
33″·69 × 6·5 =	+	3	39		·071 × 6·5 =		·46
Red. Dec. . .	19	25	44	N.	To App. T. —	3	50
	90						
N. P. D.	70	34	16		T. VIII. Dip	4′	4″
					XV. Ref.	2	3
						6	7
Obs. Alt.	25°	20′					
Dip & Ref.	—	6	7				
	25	13	53				
Semid (N. A.)	+	15	51				
Par.			8				
True Alt.	25	29	52		Tab. V.		
Lat. N.	50	50			. . . Sec.	0·199573	
N. P. D.	70	34	16		. . Cosec.	0·025463	
Sum	146	54	8				
Half-sum	73	27	4		. . . Cos.	9·454591	
Rem.	47	57	12		. . . Sin.	9·870755	
Hour-ang. & App. T. at ship 17d.	4h.	52m.	38s.		(T. XVIII.)	9·550382	
Eq. T.	—	3	50				
Ship date M.T. 17d.	4	48	48				
Gr. date M.T. 17d.	6	30	13				
Long. in time	1	41	25				
			3				
	5	4	15				
			5				
Long.	25°	21′	15″	W.			

Notes.—1. The Approx. Gr. date by Dead Reckoning is found for the purpose of knowing the Day and Hour (astron. time) of the chronometer; also to know whether it is necessary to apply 12 hours to the chron. time.

2. The Daily Rate is multiplied by the time elapsed from April 26th to May 17th, allowing a proportion for the 6 hours.

3. The Decl. and Eq. of Time, each taken from Naut. Alm. p. II. of the month, are corrected by the "Var. in 1 hour" multiplied by the Gr. time 6½ hours, or 6·5.

4. The Obs. Alt. is reduced to the True Central Alt.

5. The App. Time at ship got by method (see p. 81); being P.M. at ship, the Hour-angle is the time at ship.

6. Being P.M. at ship, put the day before it, and it is the Ship Date Apparent Time.

7. By applying the Eq. of Time according to instructions on p. I. of Naut. Alm., we get Ship Date Mean Time.

8. The difference between Gr. date M.T. and Ship date M.T. is the long. in time, which put into ° ′ ″; it is West because Gr. time is best.

Ex. 1882, Sept. 24th, at about 7h. A.M. at ship, in lat. 49° 42′ N., long., by D. R., 49° W.; the observed altitude of sun's lower limb was 10° 1′ 20″; eye 16 feet; time by chronometer 10h. 5m. 40s., which had been found 3m. 11s. slow on Green. Mean Time on July 2nd, and losing 2·5s. daily. Required the true Longitude.

Ship date Sept. 23d.	19h.	0m.	Time by chron.	10h.	5m.	40s.
D. R. long. W.	3	16		12		
				22	5	40
Approx. Gr. date, Sept. 23d.	22	16	Orig. err. slow +	0	3	11
				22	8	51
			loss +	0	3	30
By Chron. Gr. date M.T. Sept. 23d.				22	12	21

Rate 2·5s.

July 2nd to Sept. 24th = 84

100

200

6,0) 21,0·0

3m. 30s.

24th. Decl. (N. A. p. II.) 0° 31′ 33·7″ S.

58·49″ × 1·8 + 0 1 45·3

Red. decl. 0 29 48·4

90

N. P. D. 90 29 48

24th. Eq. of T. (N. A. p. II.) 8m. 0·99s.

0·863 × 1·8 = — 1·55

To App. T. — 7 59·44

Obs. Alt.	10°	1′	20″	T. VIII. Dip	3′ 56″
Dip and Ref.	—	9	16	XV. Ref.	5 20
	9	52	4		— 9 16
Semid. (N. A.)	+	15	59		
Par.			9		
True Alt.	10	8	12	Tab. V.	
Lat. N.	49	42	0	. . . . Sec.	0·189237
N. P. D.	90	29	48	. . . Cosec.	0·000017
Sum	150	20	0		
Half-sum	75	10	0	. . . . Cos.	9·408254
Rem.	65	1	48	. . . . Sin.	9·957381
Hour-ang.	4h.	54m.	24s.	(T. XVIII.)	9·554889
	24				
Ship date, App. T.	23d. 19		5	36	
Eq. T.	—		7	59	
Ship date, M.T.	23d. 18		57	37	
Green. date, M.T.	23d. 22		12	21	
Long. in time	3		14	44 = 48° 41′ W.	

Notes.—1. The ship astronomical date and longitude, giving approximate Gr. date Sept. 23d. 22h., shows that 12 hours must be added to the time by chron.

2. The Decl. and Eq. of Time are taken out for Sept. 24th and corrected for the hours and minutes that the Gr. date is short of the 24th; in this case 1h. 48m. or 1·8h.

3. For the Polar Dist. 90° is added to the Decl., since the Lat. is N. and the Decl. is S.

4. The Hour-angle being found, it must be subtracted from 24 hours, being the time from the nearest noon; and the astronomical day at ship is the 23rd.

5. The Eq. of Time is then applied according to instructions on p. I. of Naut. Alm. to get mean time.

The remaining part of the problem is the same as that of the previous problem.

Ex. 1882, April 15th at about 8h. 35m. A.M. at ship in lat. 44° 59′ S., long. by D. R. 106° W.; the observed altitude of sun's lower limb 19° 9′ with index error 1′ 31″ to add; eye 15 feet. Time by chronometer 3h. 42m. 56s., which had been found 2m. 2s.

fast on mean time at Greenwich on January 23rd, and losing 4·5s. daily. Required the true longitude.

Ship date April	14d.	20h.	35m.	Hence chron. corrected gives Gr. date April 15d. 3h. 47m. 4s.
106° long. W.		7h.	4m.	
Approx. Gr. date Apr.	15	3	39	

Cor. Dec. 9° 53′ 10″ N. Cor. Eq. T.—3s. T. alt. 19° 20′ 2″.
Hour-angle . . 3h. 18m. 3s. log. 9·243903 = sum of logs.
24

Ship date A.T.	14d.	20	41	57
Eq. T.			—	3
„ M. T.	14	20	41	54
Gr. date M.T.	15	3	47	4
Long. in time .		7	5	10 = 106° 17′ 30″ W.

Work it out in full and get the same result.

Ex. 1882, August 21st, at about 8h. A.M. at ship, in estimated long. 12° W.; the observed altitude of sun's lower 24° 29′, with index error 1′ 49″ to add; eye 14 feet; time by chron. 8h. 49m. 54s., which had been found 1m. 12s. slow on M. T. at Greenwich on May 10th, and gaining 2s. daily:—

At noon the lat. by meridian altitude of sun was found to be 60° 57′ N.; the course and distance from about 8h. A.M. until noon, having been S.E. by E. ½ E. (*true*) 17 miles. Required the longitude brought up to noon.

Course S. 5½ pts. E. and dist. 17′ = 8′ S. and 15′ E. } see pp. 26
Dep. 15′ E. in lat. 61° = 31′ diff. long. } and 27.

Gr. date M. T. by chron. Aug. 20d. 20h. 47m. 40s.

Cor. Dec. 12° 7′ 19″ N.; cor. Eq. T. + 3m.; T. alt. 24° 41′;

Lat. carried back to 8h. A.M. 61° 5′ N.;

Log. of H.-angle 9·402675 giving 4h. 1m. 27s.;

Long. at time of morning sight 11° 31′ 45″ W., and carried forward to noon = 11° 0′ 45″ W.

Work out the example and get the same results.

Note.—Being in N. lat. if you make northing in the interval between the A.M. sights and noon, your lat. for A.M. sights must be less than that at noon; for southing, greater.

Note.—Being in W. long., and having found the longitude for A.M. sights, easting in the interval decreases the long. at noon; westing increases it.

Ex. 1882, September 1st, in Long. by D. R. 7° 20′ E.; the obs. mer. alt. of sun's lower limb was 33° 0′ 30″ South of observer; eye 13 feet. At about 5h. P.M. of the same day the mean of five obs. alts. was 12° 2′, and the mean of times by Chron. Sept. 1d. 4h. 40m. 12s.; chron. had been found 1m. 11s. fast on M. T. at Greenwich on May 20th, and losing 5s. daily. Required the Latitude at noon, and brought down to the time of taking the sights; also the Longitude; the true course and distance run from noon was S. 40° W. 30 miles.

Ans. Lat. at noon 65° 3′ 3″ N.; Lat. brought down for run 64° 40′ 3″ N.; Long. 6° 47′ 45″ E.

LATITUDE BY AN EX-MERIDIAN ALTITUDE OF THE SUN.

Should the weather be cloudy and uncertain, a tolerably fair latitude may generally be obtained by taking an *altitude* of the sun when *near the meridian;* and for this purpose the error of the watch for the ship's position should be known as accurately as possible. For this problem you will naturally use Towson's "Tables for the Reduction of Ex-Meridian Altitudes." They give two corrections—one to be applied to the declination, and the other to the altitude —and then, by a process similar to the ordinary latitude problem, p. 70, you get your ship's latitude. There are limits to the time of taking the altitude, but these need not be stated here, as, if you keep within the range of Towson's Tables, you will be correct. A problem worked in full will give you an idea of the process.

The altitude may be observed at A.M. or P.M., and the *time from noon* is one of the elements. *Note.*—It is *apparent* time.

Ex. 1882, April 28th, A.M. at ship; Lat. by D. R. 47° 40′ N.; Long. 17° W.; the observed altitude off the meridian of sun's lower limb was 56° 10′ South of the observer; eye 16 feet;

time by watch 11h. 56m. 20s. A.M., which had been found 14m. 30s. fast on apparent time at ship, but the ship had made 19′ diff. long. to westward since the error for time had been found. Required the true Latitude?

	h.	m.	s.		h.	m.	s.	
Time by watch	11	56	20		24	0	0	
	12			T. at ship	23	40	34	
April 27d.	23	56	20	T. from noon		19	26	
Fast	—	14	30		°	′	″	
	23	41	50	Dec.	14	12	20	N.
Diff. Long. 19′ W.	—	1	16	Cor. for 48m.		+	38	
Ap. T. at ship, Ap. 27d.	23	40	34		14	12	58	
Long. 17° W.	1	8	0	Towson's cor.	+	2	56	
Ap. T. at Gr. Ap. 28d.	0	48	34	Aug. Dec.	14	15	54	

	°	′	″	
Obs. Alt.	56	10	0	S.
Cor. of Alt.	+	11	25	(various tables).
T. Alt.	56	21	25	
Towson's cor.	+	17	32	
Augmented Alt.	56	38	57	
	90			
Zen. dist.	33	21	3	N.
Dec.	14	15	54	N.
Lat.	47	36	57	N.

AMPLITUDE AND AZIMUTH, AND THENCE THE ERROR AND DEVIATION OF THE COMPASS.

Your chart and sailing directions will generally indicate the variation of the compass; but if you are in an iron boat, or a steamer, your compass will be affected by deviation, and this you can only find out, when at sea, by an Amplitude or an Azimuth. I will first give you a few *definitions* of terms; these you must carefully read, and reflect on: and then you will see the drift of the subsequent remarks.

1. *Amplitude.*—The arc of the horizon between an object at rising and the E. point, and the object at setting and the W. point. *Note.*—The Amplitude is only observed at sunrise and sunset.

2. *Azimuth.*—The arc of the horizon between the N. or S. point and the circle of altitude passing through a celestial body. *Note.*—The *true* Azimuth or bearing must be calculated, or otherwise taken from a Table by Inspection: the *observed* Azimuth is the object's bearing by compass.

3. *The Variation of the Compass* is the angle between the magnetic and true meridians.

4. *The Deviation of the Compass* is the angle through which the compass needle is deflected from the magnetic meridian. *Note.*—Or,—The *deviation of the compass* is the angle between the magnetic meridian and the direction of the magnetic needle influenced by the magnetism of a ship.

5. *The Error of the Compass* is the angle through which the compass needle is deflected from the true meridian. *Note.*—The *Error of the Compass* includes variation and deviation, and is the angle between the geographical meridian and the direction of the magnetic needle of the compass on board.

6. *The True Course of a Ship* is the angle that a ship's track makes with the true meridian.

7. *The Magnetic Course* is the angle that a ship's track makes with the magnetic meridian. *Note.*—The *magnetic*, or (as it is now generally called) the *correct magnetic course*, being the angle between the magnetic meridian at the place and the ship's track as shown by a compass unaffected by deviation, such a course is affected only by the variation of the compass.

8. *The Compass Course* is the angle that a ship's track makes with the compass needle. *Note.*—The *com-*

pass course being the angle between the ship's track and the direction of the magnetic needle of the compass on board, such a course may be affected with variation and deviation.

If you are in an iron ship, Tables by which you can instantaneously take out the *sun's true bearing* (*Azimuth* is only another word for *bearing*) are indispensable.

For Latitudes from 60° to 30° BURDWOOD'S "Sun's True Bearings" are sufficient.

But if you go into the tropics these must be supplemented by DAVIS' "Sun's True Bearings."

There is also LABROSSE'S "Azimuth Tables," which range from 61° N. to 61° S.

These give the Sun's *true bearings at any time that the object is above the horizon;* with explicit directions as to their use, so it is unnecessary to repeat them here. One or other of these works you must have if you wish to be well posted as to what your compass is doing, and where you are going. All I purpose now to do is, to show you how to obtain the *Error of the Compass* and the *Deviation,* when you have sought out the *true bearing* of the object, and looked at your chart for the *variation.*

1. The *True Amplitude* must be *named from* East at A.M. or rising, but from West at P.M. or setting; *towards* North for Declination N., but *towards* South for Dec. S.

Thus, in February, when the Dec. is 15° S., we should say the sun rose E. 23° 40′ S.; and, in May, when the Dec. is 20° N., we should say the sun set W. 32° 10′ N., in the Channel.

2. *For the Error of the Compass.*—Under the *true* write the *observed* (or compass) Amplitude, reckoned from the same point as the *true*, E. or W. as the case may be.

If both are N., or both S. take their difference; if

one is N. and the other S., take their sum; the result in each case will be the Error of Compass.

Then, looking from the centre of the compass in the direction of the observed Amplitude—*name* Error E. if true, is to right of observed, Amplitude; but *name* Error W. if true, is to left of observed, Amplitude.

Ex.	True Amplitude	E. 15° 20′ N.		True Amp. .	W. 5° 40′ S.
	Observed „	E. 28 50 N.		Obs. „ .	W. 8 17 N.
	Error of Compass	13 30 E.		Err. of Comp.	13 57 W.

Note.—The observed Amplitude is of course the object's bearing by compass at rising or setting. If you have no deviation, the Err. of Compass is the Variation.

3. For the *True Azimuth,* you will find that in the works to which I have referred (p. 93), Burdwood, Davis, and Labrosse, the bearing of the object is *named from* N. in N. Latitude, but *from* S. in S. Lat., *towards* E. before it comes to the meridian, but towards W. after it has passed the meridian. Hence if *true* and *observed* Az. have different names, one N. and the other S., they can be brought into the same name by subtracting one from 180°; thus S. 110° E. = N. 70° E.

4. *For the Error of the Compass.*—Under the True Azimuth write the *observed* Azimuth or Bearing, both reckoned from the same point, N. or S.; then—

If both are E., or both W., take their difference; if one is E. and the other W., take their sum; the result in each case will be the Error of Compass.

Then, looking from the centre of the compass in the direction of the observed Azimuth—*name* Error E. if true, is to right of observed, Azimuth; but *name* Error W. if true, is to left of observed, Azimuth.

Ex.	True Az. . . .	N. 136° W.		*Ex.* True Az. . . .	N. 64° W.
	Obs. „ . . .	N. 89 W.		Obs. „ . . .	N. 88 W.
	Err. of Comp.	47 W.		Err. of Comp.	24 E.

Ex. True Az. . . .	N. 101° E.	*Ex.* True Az. . . .	N. 15° W.
„ „ . . .	S. 79 E.	Obs. „ . . .	N. 3 E.
Obs. „ . . .	S. 69 E.	Err. of Comp.	18 W.
Err. of Comp.	10 W.		

Thus far, whether by Amplitude or Azimuth, you know how to find the Error of the Compass; but we must go a step further.

5. *For the Deviation of the Compass.*—Under the Error of Compass write the Variation as given on Chart; then with Error and Var., both E. or both W., take their difference;—but with Error and Var., one E. and the other W., take their sum.

The resulting Deviation will be of the *same name as the Error* of Compass; *unless* the Error has been *subtracted* from the Variation, in which case the Deviation will be *E. when Error is W.*, but *W. when Error is E.*

Also, with Error 0, Deviation is of the same amount as the Variation, but of the opposite name; with Variation 0, the Error is the Deviation.

Remember that the *Deviation* thus obtained is that *due to the course on which the ship's head may be* at the time of making the observation.

Ex. On June 1st you are in Lat. 48° N., Long. 34° W.; the ship is heading N.W. ½ W. by compass; at about 7h. 15m. A.M. you take the Sun's Bearing by Compass as S. 79° E.; you then see from the Naut. Alm. that the Sun's Dec. is about 22° N.; you turn to the given Lat., and for the corresponding Dec. and Time, you find the True Bearing=N. 88° E.; you then work the *Ex.* as at the side, and find that the Dev. with the ship's head N.W. ½ W. is 22° E.; and that since the Err. of the Comp. on that point is 13° W., the course made good will be N. 63½° W. or N.W. by W. ¾ W.

By book, T. Bearing	N. 88° E.
„	S. 92 E.
Obs. „	S. 79 E.
Err. of Comp. . .	13 W.
Var. by Chart . .	35 W.
Deviation	22 E.

This is a Time Azimuth, which requires no observed altitude; and if you change your course twenty times

a day you can always, in a few minutes, know the exact course you are making.

Ex. September 2nd; Lat. 39° N.; Long. 48° W.; at 3h. 45m. P.M. app. time at ship; sun bore by compass N. 80° W.; ship heading by compass South; sun's Dec. 8° N.; sun's true bearing N. 106° W.; Variation 23° W.

Ans. Err. of Comp. 26° W.; Dev. 3° W.; True Course S. 26° E.

Ex. October 3rd; Lat. 50° N.; Long. 15° W.; at 8h. A.M. app. time at ship; sun bore by compass S. 28° E.; ship heading by compass West; sun's Dec. 4° S.; sun's true bearing N. 116° E.; Variation 27° W.

Ans. Err. of Comp. 36° W.; Dev. 9° W.; True Course S. 54° W.

Ex. May 16th; Lat. 61° N.; Long. 22° W.; at 4h. 32m. A.M. app. time; ship heading by compass S.E.; sun bore by compass N. 60° E.; sun's Dec. 19° N.; sun's true bearing N. 62° E.; Variation 42° W.

Ans. Err. of Comp. 2° E.; Dev. 44° E.; True Course S. 43° E.

Ex. August 24th; Lat. 49° N.; Long. 30° W.; sun rose by compass East; ship heading by compass N. by E. ½ E.; Variation 35° W.; sun's true Amplitude E. 17° N.

Ans. Err. of Comp. 17° W.; Dev. 18° E.; True Course North (nearly).

Ex. August 1st; Lat. 50° N.; Long. 15° W.; sun set by compass N. 21° W.; ship heading by compass N. ½ E.; Variation 27° W.; sun's true Amplitude W. 29° N.

Ans. Err. of Comp. 40° W.; Dev. 13° W.; True Course N. 37° W.

Note.—For a Time-Azimuth use *apparent* time.

GREAT CIRCLE SAILING.

THE earliest works on Navigation treat on Great Circle Sailing, and many of the early navigators, when traversing the Atlantic and Pacific, availed themselves of its principles when they found that they could do so with advantage. But land, ice, wind and weather, current, or other causes, considerably limit the adoption of this method of sailing.

Mercator and Parallel Sailing conduct the ship by a circuitous route, when compared with the track of a Great Circle; but the simplicity of the calculations connected with these modes of sailing, and the circumstance that by compass the ship's track showed but one course from port to port, led to the adoption of the two systems above named in preference to Great Circle Sailing, in which the course is continually changing.

The following elucidations, from Lieutenant Raper's valuable "Practice of Navigation," present, in various points of view, the difference between Mercator Sailing and Great Circle Sailing. By Mercator Sailing "the ship crosses at the same angle all the meridians which she passes over; that is, her head is kept *on the same point of the compass* until she reaches her intended port; and in this consists the convenience of these sailings. The track of a ship thus steered is, however, very different from the *shortest distance* between any two

places, or the distance as the crow flies; the sailing by which the direct course to a place is to be shaped is called *Great Circle Sailing.*"

"The course on the rhumb-line from one of two places to the other is exactly the opposite of the course to that place from the other; while on the Great Circle these courses are very different. The ship, while on the rhumb-line, is always changing the direction of her head with respect to her port, for which she never steers exactly until it is in sight, because this track cuts all the meridians at the same angle, and the meridians themselves are not parallel to each other; but on a great circle she steers directly for her port, while the angle made by her track is perpetually varying."

"The track on the great circle and that on the rhumb-line differ most widely from each other in high latitudes, and between places on nearly the same parallels. . . . . When the ship sails on a great circle between two places, without crossing the equator, she is always in a *higher* latitude than if she had sailed by a rhumb-line: hence, since both tracks coincide at their extremities, there must be a point in the great circle at which the distance, measured on a meridian to the rhumb-line, is greater than anywhere else. When the ship crosses the equator, there are two such points, the one being to the northward of the rhumb-line in north latitude, and the other to the southward of the rhumb-line in south latitude."

To determine, by calculation, how much the Great Circle course must be changed from time to time, is a very tedious process, and one little likely to be welcome to the navigator. Unless the results could be tabulated, so as to leave nothing but a few easy rules to observe, Great Circle Sailing would ever be an exceptionable system: now this is precisely the nature

of the service rendered to Navigation by Mr. John Thomas Towson's "Tables to facilitate the Practice of Great Circle Sailing." By means of a diagram and a table of easy entry, the whole operation of finding several courses in succession is reduced almost to a matter of inspection.

If the reader have a terrestrial globe before him, it would afford a means of reference and illustration more useful than anything else, in respect to the principles of Great Circle Sailing; but a map would to a certain degree be useful for the same end. It is one of the most familiar propositions in Spherical Geometry, that the shortest line which can be drawn between any two places on the surface of the globe is an arc of the great circle that passes through them both; while, on the other hand, the smallest study of the nature of a rhumb-line, the course followed in ordinary sailing, will show that the rhumb from one place to another can never coincide with a great circle, unless both of those places lie either on the equator or on a common meridian. Maps and charts, being *flat* representations of *curved* surfaces, are of necessity distorted, and are only correct near the equator; the distortion increasing as the poles are approached. One consequence of this is, that the relative advantages of Mercator and Great Circle Sailing are not readily seen on a common map or chart; for the course which on the globe is the shortest, is on the chart made to appear very much the longest, and *vice versâ*. In a perfect great circle (neither on a meridian nor on the equator), the course is *perpetually* changing; it does not remain the same at two places even a degree asunder. But in practice it is necessary to break up the course into a number of stages, each having a definite direction for a short distance. It is this breaking up of the great circle

into a large number of practical sailing courses that Mr. Towson has so conveniently effected in his Tables.

The Tables give the Latitudes, Courses, and Distances on the great circles of the globe, corresponding to each degree of longitude. Supposing a voyage to be determined on, and the latitudes and longitudes of the port of departure and the port of destination given, then the Tables would show what course between the two ports would coincide with an arc of a great circle, and would consequently be the shortest. The voyage is to be performed, as it were, in a series of stages, each stage being marked by a particular course, and then another course for the next following stage. The stages vary in length in a ratio depending on the number of miles contained in a degree of longitude, which number decreases as we approach the poles from the equator; and at each successive stage the compass course or bearing is changed.

It follows from the nature of great circles (of which the equator is one), that the northern and southern halves of a great circle must each have a point of greatest separation from the equator, and equally distant from it; and these points give rise to many designations and quantities in Mr. Towson's Tables. Thus, either of these points is called the *vertex* of the great circle to which it belongs; the arc intercepted between the vertex and the equator is the *latitude of vertex;* the meridian that passes through the vertex is the *meridian of vertex;* and the arc of the equator contained between the meridian of vertex and the meridian of any place on the great circle is the *longitude from vertex.* The meridian of the vertex always intersects the great circle at right angles, and, with the equator, divides a great circle into quadrants; and in each of [illegible] quadrants the elements are the same; that is,

the latitudes, courses, and distances corresponding to each degree of longitude from the vertex in one quadrant, truly represent those for the corresponding degree in each quadrant belonging to the same great circle; so that in practice the calculations for 90° are available for 360°, with a little attention as to east and west, and north and south.

Full instructions on the use of the Tables and the *Linear Index* which accompanies them are given in the work itself, to which the reader is referred.

A variation of this system is known by the name of *Windward Great Circle Sailing*. When a ship is unable, on account of adverse winds, to sail directly to her port, she is put on that tack by which she nears her port by the greatest proportion of the distance sailed. For example, if her proper course be due N.E., but if unfavourable winds compel her to take a course a little N. or S. of that direction, that deviation or tack ought to be adopted which will in the end least lengthen the voyage. But this nearest distance can only be determined by great circle sailing, since it is only this system which gives the *true course*, and which consequently can show which is the best tack. The rule for windward sailing, as laid down by Mr. Towson, is this: Ascertain the great circle course by the index, scale, and tables, and put the ship on that tack which is the least removed from it.

Another variety of the system is *Composite Great Circle Sailing*. Theoretically, great circle sailing is complete: it gives absolutely the shortest course between two ports; but practically, there may be reasons against its full adoption. The *vertex* of the course may be in such a high latitude, that ice, or polar lands, or other obstructions, may lie in the way. Hence the mariner may be induced to make a compromise between

parallel sailing and great circle sailing, by using a portion of each. The method of proceeding in such a case is as follows: the mariner determines what shall be the highest latitude which he is willing to reach; this he will call the "maximum latitude." He takes this latitude as the latitude of vertex, and marks out a great circle course corresponding thereto. When the ship has reached the vertex, which will necessarily be as soon as she has attained the maximum latitude, the voyage is conducted along the parallel east or west, until the difference of longitude of the ship and destination shows that the ship has reached the vertex of the arc which passes through the destination. After this, the ship follows the arc of a great circle to her destination. In this system there is a saving of distance, as compared with Mercator Sailing, near the beginning and the end of the voyage; while the middle portion is lengthened for the sake of keeping within a practicable latitude.

When a vessel gets off the Great Circle course, it will not be necessary, in practice, to calculate the course anew, since a moderate deviation will not sensibly alter the bearing of the port to which bound.

A ready way of finding the Great Circle route when elaborate rules and linear tables are not available, is Sir G. B. AIRY's (Astronomer Royal) "Method for Sweeping an Arc of a Circle" on Mercator's chart; it approaches very near to the correct projection of a great circle, on one side of the equator.

1. Join the two places by a straight line. Find its middle. Draw thence a perpendicular to that line on next the equator, and, if necessary, continue it e equator.

2. With the middle latitude (between the two places) enter the following table, and take out the corresponding parallel.

3. The centre of the required sweep will be the intersection of this parallel with the perpendicular.

Middle Lat.		Corresponding Parallel.	
20°	.....	81°	13′
22	.....	78	16
24	.....	74	59
26	.....	71	26
28	.....	67	38
30	.....	63	37
32	.....	59	25
34	.....	55	5
36	.....	50	36
38	.....	46	0
40	.....	41	18
42	.....	36	31
44	.....	31	38
46	.....	26	42
48	.....	21	42
50	.....	16	39
52	.....	11	33
54	.....	6	24
56	.....	1	13

Opposite Name.

Middle Lat.		Corresponding Parallel.	
58°	.....	4°	0′
60	.....	9	15
62	.....	14	32
64	.....	19	50
66	.....	25	9
68	.....	30	30
70	.....	35	52
72	.....	41	14
74	.....	46	37
76	.....	52	1
78	.....	57	25
80	.....	62	51

Same Name.

The distance between Tairoa Head (Otago) and Panama is 6823 miles by Mercator, and 6608 miles by Great Circle Sailing.

From the Cape of Good Hope to Cape Horn the distance by Mercator is 3792 miles, by Great Circle 3590 miles.

From Cape Clear to St. John (Newfoundland) the distance by Mercator is 1751 miles, by Great Circle 1676 miles.

THE

INTERNATIONAL

(COMMERCIAL)

CODE OF SIGNALS.

"The International Code of Signals for the Use of All Nations" was, on its first publication in 1857, known as the "Commercial Code of Signals." The more comprehensive title has since been adopted, owing to its acceptance by all maritime nations as the means of communication between passing ships, and between ships and signal stations placed along the coast, for which purpose *translations* of the Code have been made by order of the different governments.

The characteristics of the Code are *comprehensiveness* and *distinctness.*

Its comprehensiveness consists in the ability of the Code to give upwards of 78,000 Signals, each made in one Hoist, in one place, without the use of Distinguishing or Repeating Flags or Pennants, no Hoist being ever composed of more than Four Flags.

Its distinctness is shown in the circumstance that separate and particular Signals, *distinguished by the form of the Hoist,* are, to use a common expression, made to *tell their own tale.*

THE CODE FLAGS.

The International Code consists of 18 Flags, viz.:—

1 Burgee,
4 Pennants,
13 Square Flags;

and *in addition* a *pennant* called the *Code Signal*, which is *also* the *Answering Pennant*.

The 18 Flags represent the Consonants of the Alphabet, viz., B, C, D, F, G, H, J, K, L, M, N, P, Q, R, S, T, V, and W; these are shown on the coloured plate *facing Title*, but may be described as follows:—

BURGEE.

B Red, swallow tail, is the *Burgee*.

PENNANTS.

C Clear (or White) Pennant.
D Dark (or Blue) ,,
F Fiery (or Red) ,,
G Yellow and Blue (*vertical*) ,,

SQUARE FLAGS.

H White and Red (*vertical*).
J Blue, White, and Blue (*horizontal*).
K Yellow and Blue (*vertical*).
L Blue and Yellow (*in four chequers*).
M Blue, with white *cross* from corners.
N Blue and White (*in sixteen chequers*).
P *Blue Peter*.
Q Yellow (*Quarantine flag*).
R Red, with Yellow *cross* (*vertical and horizontal*).
S White, with Blue *centre*.
T Red, White, and Blue (*vertical*), *i.e. Tricolour*.
V White, with Red *cross* from corners.
W Blue, White, and Red; *i.e.* Blue *outside*, then White, with Red *centre*.

CODE SIGNAL *or* ANSWERING PENNANT.

Pennant, in *alternate* Red and White *vertical stripes.*

Note.—When used as the "Code Signal" this Pennant is to be hoisted under the "Ensign"; when used as the "Answering Pennant" hoist it where best seen.

Note.—These Flags represent certain letters of the alphabet, *not as alphabetical letters, whereby a word or set of words (to form a sentence) can be spelt,* BUT *as arbitrary Signs or Symbols.*

Having learnt to distinguish the Flags, it is equally necessary that you should understand the *special and distinctive character of the various Signals, as indicated by the Form of the Hoist and Upper Flag.*

DISTINCTIVE CHARACTER OF SIGNALS MADE BY FLAGS.

A *Single* Flag, when used, may be—

The *Code* Pennant, which is *also* the *Answering* Pennant.

The *White* Pennant (C) signifies *Yes:* (Affirmative).

The *Blue* Pennant (D) signifies *No:* (Negative).

Note.—All other Code Signals are made with *Two, Three,* or *Four* FLAGS *in a hoist,* and the special *character* of the Signal is *indicated by the Upper Flag* of the hoist.

TWO-*Flag Signals* having—

The *Burgee* uppermost, are *Attention* or *Demand* Signals.

A *Pennant* uppermost, are *Compass* Signals.*

* The *Compass* Signals, in points and half points, are *Correct Magnetic;* those ranging—

From North to E. ½ N. have pennant C uppermost.
From East to S. ½ E. have pennant D uppermost.
From South to W. ½ S. have pennant F uppermost.
From West to N. ½ W. have pennant G uppermost.

Each pennant with the Flag W *underneath* indicates some special *Meteorological Report.*

A *Square Flag* uppermost, are *Urgent, Danger*, or *Distress* Signals.*

THREE-*Flag Signals* are—

General or Universal,† and *relate to all ordinary subjects* of inquiry or communication appertaining to Ships and Shipping, Crew, Passengers, Emigrants, Cargo, Provisions, Letters, Mails, News, Sick, Quarantine, Books and Instruments of Navigation, Lights and Buoys, Soundings, Latitude, Longitude, Time, Weather, Winds, Police, Officials, Repairs, Stores, Spars, Supplies, Engineers, Engines, Anchorage, Pilots, Tides, Money, Value, Quantity, Numbers, Address, &c., &c.

FOUR-*Flag Signals* having—

The *Burgee* uppermost, are *Geographical Signals*.‡

The *Pennant* C, D, or F uppermost, are *Spelling* and *Vocabulary Signals*.

The *Pennant* G uppermost, are *names of Men-of-War*.§

A *Square Flag* uppermost, are *names of Merchant Ships* and also of *Yachts*.§

* *Urgent* Signals range from HB to SD, and relate to *distress, danger, caution, directions to a vessel under weigh or at anchor, fire, leak, various wants, need of assistance, communication with shore*, &c., &c.

† *General* Signals, with flag F, G, or H *uppermost*, relate to Latitude, Longitude, Time, Nautical Instruments and Books, Weather, Wind, Storm, Fog, Ice, and Sea.

‡ Countries, Ports, Harbours, Islands, Capes, Seas, Gulfs, Bays, Channels, &c., are included under this head, and generally arranged according to their coast-line and contiguity: with Alphabetical Index. Signal Letters B C D F to B T K G.

§ For these signals you must use the *British Code List* for the year, which gives the Signal Letters assigned to Men-of-War, Merchant Vessels, and Yachts, thus—

G S D F is H.M.S. "*Iron Duke*."

Q T F G is the "*Pericles*," of Aberdeen, of 1,598 tons.

N T G F is the sc. st. yacht "*Sunbeam*," of the Royal Yacht Squadron.

INSTRUCTIONS ON USING THE FLAGS.

Show the Ensign *and* the Code Signal *under* it when necessary to signify that the International Code is used.

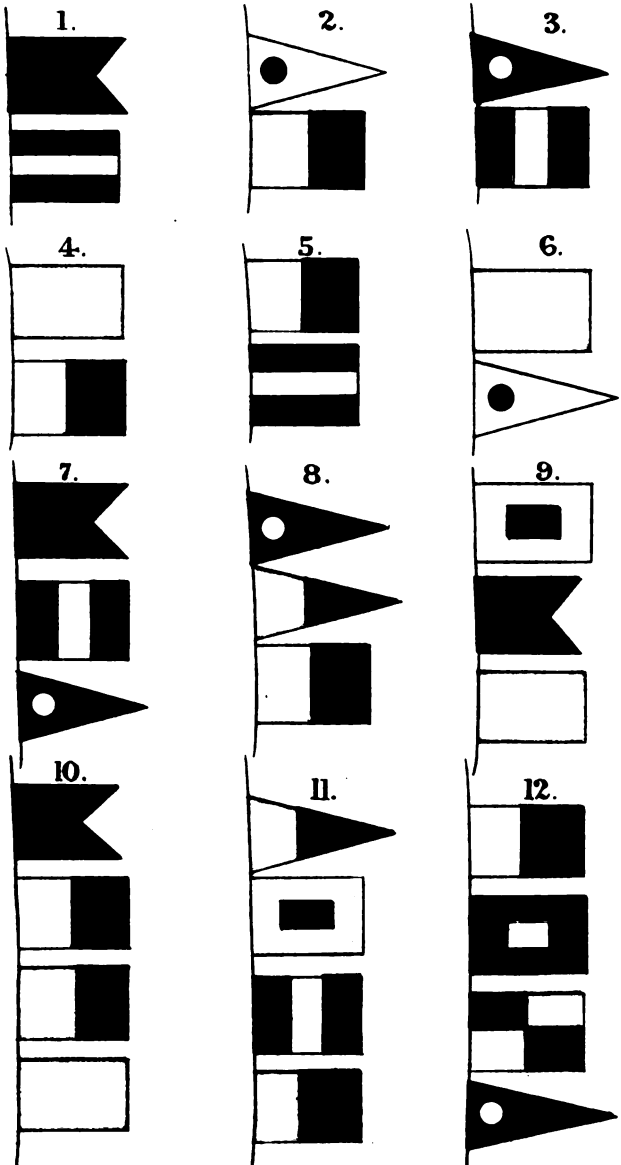
The Flags making the Signal should be hoisted at the Masthead, if possible; or otherwise, where they may best be seen.

EXAMPLES ILLUSTRATING THE FORM OF HOIST.

(*See Coloured Plate.*)

1. *Attention* signal B J signifies "Show your distinguishing signal."
2. *Compass* signal C K signifies "N.E. *b* N."
3. *Compass* signal F T signifies "W. *b* S."
4. *Urgent* signal Q H signifies "Heave to, I have something important to communicate."
5. *Urgent* signal K J signifies "Get her on the other tack, or you will be on shore."
6. *Urgent* signal Q C signifies "Repeat your signal; it is not understood."
7. *General* signal B T F signifies "I will wait while you write."
8. *General* signal F G H signifies "What is your longitude, brought up to the present moment?"
9. *General* signal S B Q signifies "Report me by telegraph to Lloyd's."
10. *Geographical* signal B H K Q signifies "Port Vecchio."
11. *Name of Man-of-War* G S T K signifies "Her Majesty's ship (tw. sc.) *Northampton.*"
12. *Name of Merchant Vessel* H P L D signifies "*Russia* of Glasgow (steamer) 1,710 tons, 600 h.p."

Note.—A *homeward bound* ship passing another ship should hoist B P W, "Do you wish to be reported?" and report the Distinguishing Signals given in reply.


1.
2.
3.
4.
5.
6.
7.
8.
9.
10.
11.
12.

From the Spelling Table, to spell the name *Nelson* you must make three separate hoists, as follows:—

C D R V	C D N Q	C D V N
Ne	*ls*	*on*

DISTANCE SIGNALS.

The *Colours* of the Code Flags may be rendered indistinct through excessive distance: or haze may equally interfere to mask the colour, but not the shape, of a flag; therefore, that no opportunity of communicating at sea should be lost, a system of Distance Signals has been introduced into the International Code Signal Book.

Also for the purpose of facilitating communication, the *Distance Signals hoisted singly* and followed by "Stop," have a special signification importing *urgency*.

The *characteristic* of the Distance Signal is the *Ball*—one Ball at least appearing in every hoist of the Distance Code: the two other symbols may be Pennants or Square Flags of any colour.

It will be seen from the woodcut (p. 111) of Distance Signals that the Code has been so arranged as to give the least possible trouble in finding the combination required; thus—

The *first* column (B to H) contains all the combinations having the *Ball* or *Balls first* or *uppermost* in the hoist.

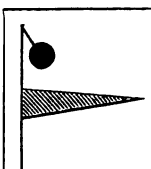
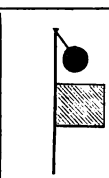
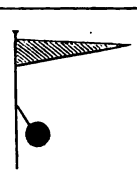
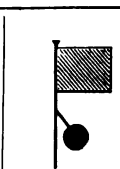
The *second* column (J to P) contains all the combinations having the *Ball* or *Balls second* or *separated* in the hoist.

The *third* column (Q to W) contains all the combinations having the *Ball* or *Balls last* or *lowermost* in the hoist.

SIGNIFICATIONS of the DISTANCE SIGNALS when made *singly*, which will be indicated by the "*stop*" following each Hoist.

B. Asks name of ship, or Signal Station, in sight.
C. Yes.
D. No.
F. Repeat Signal, or hoist it in a more conspicuous place.
G. Cannot distinguish your Flags. Come nearer, or make Distance Signals.
H. You may communicate by the Semaphore, if you please.
J. Stop, or bring to. Something important to communicate.
K. Have you any telegrams or dispatches for me?
L. Want a pilot. Can I have one?
M. Want a tug. Can I have one?
N. What is the Meteorological Weather Forecast?
P. Calls attention of Signal Station in sight.
Q. Vessel asks for orders by telegraph from owner, Mr. —— at ——.
R. Report me by telegraph to my owner, Mr. —— at ——.
S. Send the following message by telegraph,
T. Send the following message, by the *Signal Letters*, through the telegraph.

In addition to the above, the following Distance Signals composed of *Two Symbols* have the special signification indicated beneath:—

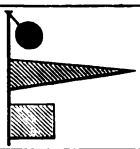
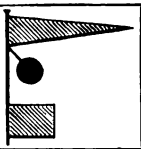
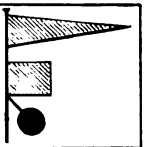
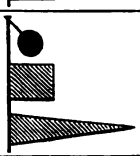
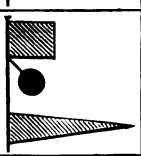
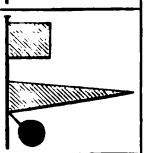
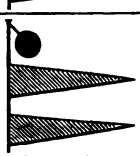
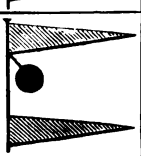
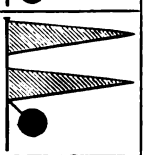
			
You are running into Danger.	Fire: or Leak. Want immediate assistance.	Short of Provisions. Starving.	Aground. Want immediate assistance.

GENERAL ALPHABETICAL TABLE FOR COMPOSING DISTANCE SIGNALS.

Preparative Answering

and also
Stop after each complete Signal.

Annul Signal.

B 	J 	Q 
C 	K 	R 
D 	L 	S 
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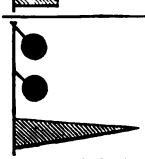
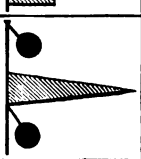
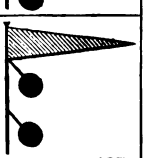
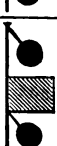
G 	N 	V 
H	P 	W

SEMAPHORE SIGNALS.

Semaphores, or Signal Stations, have been established along many parts of the coast of Europe for the purpose of communicating with passing ships.

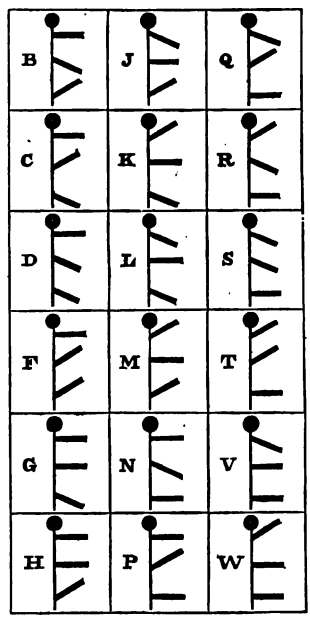
Semaphore masts are furnished with *Three Arms*, which are used as follows in the representation of any of the Distance Signals :—

1. The *Disc* at the *top of the mast* indicates that signals are being made by the *International Code*, and it must remain there whilst so signalling. It is a large *black disc with white rim.*

2. Any *arm* pointing *downwards* represents a PENNANT.

3. Any *arm* in a *horizontal* position represents a BALL.

4. Any *arm* pointing *upwards* represents a FLAG.



When the arms are not working they are not visible, but lie parallel with the masts.

The *Semaphore Signals* are always to be *read off as Distance Signals;* and a *single* Semaphore letter (or symbol) has the same signification as a Distance Signal when made *singly.* All communications between passing ships and the Semaphores are to be made *exclusively by the Signals of the International Code.*

At a moderate distance the Signal Flags of the Code can, of course, be used by both Ships and Signal Stations, but the *Distance Signals* should on all occasions be employed by ships when it is found that the Code Flags cannot be made out.

BOAT SIGNALS.

The Symbols to be employed for Boat Signals are:—

1. Two *square* flags, or handkerchiefs, or pieces of cloth of any colour.
2. Two whefts or strips of cloth of any colour, or parts of a plank longer than broad.
3. Two balls, bundles, hats, or buckets.

With these any of the *Distance Signals* can be made by holding the Symbol at arm's length; the Signal will be *made from right to left* and be *read from left to right*, thus:—

Equivalent to Ball above Pennant, or "You are running into Danger" (see p. 110).

J.

B.

Equivalent to J B, and signifying "Accident; want a Surgeon."

"Stop," or finish after each complete signal.

In making Boat Signals it is important to use only the proper means to attract attention, and to avoid those that may occasion confusion, or may be misinterpreted.

It now remains to give a few hints as to—

HOW TO USE THE SIGNAL BOOK IN MAKING OR INTERPRETING A SIGNAL.

In the Signal Book of the International (Commercial) Code the combinations of Flags forming the *entire series of Signals* from B C to F G M D *follow in consecutive order*, so that with ordinary intelligence, a Signal can readily be made or interpreted as the case requires.

The book consists of three parts.

Part I. contains, in successive order—

The 2-Flag Signals, of which those with Square Flag uppermost, *when made at sea*, should never be disregarded, as in all probability they may indicate *danger* or *distress*;—

The 3-Flag Signals, for *general communications* and *enquiries*, as between passing ships, or between a ship and a shore station; to these succeed the *Numeral*, *Address*, and *Alphabetical* Tables; and, finally—

The 4-Flag Signals with Burgee uppermost, all of which are *Geographical*.

Part II. commences with—

The Alphabetical Spelling Table, which is a 4-Flag Signal having Pennant C uppermost. This is followed by a—

Vocabulary and Index to the Signals in Part I.; and you may *note* that the principal or leading words

are, in this portion of the book, *arranged alphabetically after the manner of a Dictionary;* every Signal which has appeared in Part I. is inserted in its proper alphabetical order, with the *Signal Letters* placed *to the right.* But there are also many additional 4-Flag Signals which are not included in Part I., and for these the Signal Letters are placed to the left; they begin with C H B D and end with F G M D.

The Alphabetical Geographical Index closes Part II.

Part III. relates to Distance Signals, Semaphore and Boat Signals.

For Making a Signal, invariably refer to Part II. of the Signal Book.

To Interpret or understand the meaning of a Signal, refer to Part I. of the Signal Book, *unless* it be a 4-Flag Signal other than a Geographical one, in which case it will be found in Part II. to the left of the column.

For a Ship's Name, refer to the Code List for the year.

THE BRITISH CODE LIST

is an Appendix to the International Code of Signals, and contains the names of British ships to which Signal Letters have been allotted: 1,440 Signals, from G Q B C to G W V T, are reserved for the Distinguishing Signals of Men-of-War and H.M.'s Indian Marine; and 53,040 Signals from H B C D to W V T S are for Merchant Vessels. There are also a few signal letters reserved for Yachts.

INTERNATIONAL STEERING AND SAILING RULES.

From an Order in Council, dated 9th January, 1863, *and in operation since 1st June,* 1863.

REGULATIONS FOR PREVENTING COLLISIONS AT SEA.

PRELIMINARY.

Art. 1. In the following Rules every Steam Ship which is under sail and not under Steam is to be considered a Sailing Ship; and every Steam Ship which is under Steam, whether under Sail or not, is to be considered a Ship under Steam.

RULES CONCERNING LIGHTS.

Art. 2. LIGHTS.—The Lights mentioned in the following Articles numbered 3, 4, 5, 6, 7, 8, and 9, and no others, shall be carried in all Weathers from Sunset to Sunrise.

Art. 3. LIGHTS FOR STEAM SHIPS.—Seagoing Steam Ships, when under weigh, shall carry :—

(*a*) AT THE FOREMAST HEAD, a bright White Light, so fixed as to show an uniform and unbroken Light over an Arc of the Horizon of 20 Points of the Compass; so fixed as to throw the Light 10 Points on each Side of the Ship, viz.,

from right ahead to 2 Points abaft the Beam on either Side; and of such a Character as to be visible on a dark Night, with a clear Atmosphere, at a Distance of at least Five Miles:

(*b*) ON THE STARBOARD SIDE, a Green Light so constructed as to show an uniform and unbroken Light over an Arc of the Horizon of 10 Points of the Compass; so fixed as to throw the Light from right ahead to 2 Points abaft the Beam on the Starboard Side; and of such a Character as to be visible on a dark Night, with a clear Atmosphere, at a Distance of at least Two Miles:

(*c*) ON THE PORT SIDE, a Red Light, so constructed as to show an uniform and unbroken light over an Arc of the Horizon of 10 Points of the Compass; so fixed as to throw the Light from right ahead to 2 Points abaft the Beam on the Port Side; and of such a Character as to be visible on a dark night, with a clear Atmosphere, at a Distance of at least Two Miles:

(*d*) The said Green and Red Side Lights shall be fitted with inboard Screens, projecting at least Three Feet forward from the Light, so as to prevent these Lights from being seen across the Bow.

Art. 4. LIGHTS FOR STEAM SHIPS WHEN TOWING.—Steam Ships, when towing other Ships, shall carry Two bright White Masthead Lights vertically, in addition to their side lights, so as to distinguish them from other Steam Ships. Each of these Masthead Lights shall be of the same Construction and Character as the Masthead Lights which other Steam Ships are required to carry.

Art. 5. LIGHTS FOR SAILING SHIPS.—Sailing Ships, under weigh, or being towed, shall carry the same

Lights as Steam Ships under weigh, with the Exception of the White Masthead Lights, which they shall never carry.

Art. 6. Exceptional Lights for Small Sailing Vessels.—Whenever, as in the case of small Vessels during bad Weather, the Green and Red Lights cannot be fixed, these Lights shall be kept on Deck, on their respective Sides of the Vessel, ready for instant Exhibition; and shall, on the approach of or to other Vessels, be exhibited on their respective Sides in sufficient Time to prevent Collision, in such manner as to make them most visible, and so that the Green Light shall not be seen on the Port Side, nor the Red Light on the Starboard Side.

To make the Use of these portable Lights more certain and easy, the Lanterns containing them shall each be painted Outside with the Colour of the Light they respectively contain, and shall be provided with suitable Screens.

Art. 7. Lights for Ships at Anchor. — Ships, whether Steam Ships or Sailing Ships, when at Anchor in Roadsteads or Fairways, shall exhibit, where it can best be seen, but at a Height not exceeding Twenty Feet above the Hull, a White Light, in a globular Lantern of Eight Inches in Diameter, and so constructed as to show a clear uniform and unbroken Light visible all round the Horizon, and at a Distance of at least One Mile.

Art. 8. Lights for Pilot Vessels.—Sailing Pilot Vessels shall not carry the Lights required for other Sailing Vessels, but shall carry a White Light at the Masthead, visible all round the Horizon,—and shall also exhibit a Flare-up Light every Fifteen Minutes.

Art. 9. LIGHTS FOR FISHING VESSELS AND BOATS.—Open Fishing Boats and other open Boats shall not be required to carry the Side Lights required for other Vessels; but shall, if they do not carry such Lights, carry a Lantern having a Green Slide on the one side and a Red Slide on the other Side; and on the Approach of or to other Vessels, such Lantern shall be exhibited in sufficient time to prevent Collision, so that the Green Light shall not be seen on the Port Side, nor the Red Light on the Starboard Side.

Fishing Vessels and open Boats when at Anchor, or attached to their nets and stationary, shall exhibit a bright White Light.*

Fishing Vessels and open Boats shall, however, not be prevented from using a Flare-up in addition, if considered expedient.*

RULES CONCERNING FOG SIGNALS.

Art. 10. FOG SIGNALS.—Whenever there is a Fog, whether by Day or Night, the Fog Signals described below shall be carried and used, and shall be sounded at least every Five Minutes, viz. :—

(*a*) Steam Ships under weigh shall use a Steam Whistle placed before the funnel, not less than eight feet from the deck :

* DRIFT NET FISHING.

Lights to be carried by English and French Boats.

1. Boats fishing with drift nets shall carry on one of their masts Two bright White lights placed *vertically* and not less than three feet apart, all the time the nets shall be in the sea between sunset and sunrise.

2. No boat shall anchor between sunset and sunrise on grounds where drift net fishing is actually going on.

This does not apply to anchorings which may take place in consequence of accident, or any other compulsory circumstances; but in such case the master of the boat thus obliged to anchor shall hoist two bright lights horizontally, and not less than three feet apart.

(*b*) Sailing Ships under weigh shall use a Fog Horn:

(*c*) Steam Ships and Sailing Ships, when not under weigh, shall use a Bell.

STEERING AND SAILING RULES.

Art. 11. Two Sailing Ships Meeting.—If two Sailing Ships are meeting End on or nearly End on so as to involve Risk of Collision, the Helms of both shall be put to Port, so that each may pass on the Port Side of the other.

Art. 12. Two Sailing Ships Crossing.—When two Sailing Ships are crossing so as to involve Risk of Collision, then, if they have the Wind on different Sides, the Ship with the Wind on the Port Side shall keep out of the Way of the Ship with the Wind on the Starboard Side; except in the Case in which the Ship with the Wind on the Port Side is close hauled and the other Ship free, in which case the latter Ship shall keep out of the Way; but if they have the Wind on the same Side, or if One of them has the Wind aft, the Ship which is to windward shall keep out of the Way of the Ship which is to leeward.

Art. 13. Two Ships under Steam Meeting.—If two Ships under Steam are meeting End on or nearly End on so as to involve Risk of Collision, the Helms of both shall be put to Port, so that each may pass on the Port Side of the other.

Art. 14. Two Ships under Steam Crossing.—If two Ships under Steam are crossing so as to involve Risk of Collision, the Ship which has the other on her own Starboard Side shall keep out of the Way of the other.

Art. 15. Sailing Ship and Ship under Steam.—If two Ships, one of which is a Sailing Ship, and the

other a Steam Ship, are proceeding in such Directions as to invole Risk of Collision, the Steam Ship shall keep out of the way of the Sailing Ship.

Art. 16. SHIPS UNDER STEAM TO SLACKEN SPEED.—Every Steam Ship, when approaching another Ship so as to involve Risk of Collision, shall slacken her Speed, or, if necessary, stop and reverse; and every Steam Ship shall, when in a Fog, go at a moderate speed.

Art. 17. VESSELS OVERTAKING OTHER VESSELS.—Every Vessel overtaking any other Vessel shall keep out of the way of the said last-mentioned Vessel.

Art. 18. CONSTRUCTION OF ARTICLES 12, 14, 15, and 17.—Where by the above Rules One of Two Ships is to keep out of the Way, the other shall keep her Course, subject to the Qualifications contained in the following Article.

Art. 19. PROVISO TO SAVE SPECIAL CASES.—In obeying and construing these Rules, due regard must be had to all Dangers of Navigation; and due regard must also be had to any special Circumstances which may exist in any particular Case rendering a Departure from the above Rules necessary in order to avoid immediate Danger.

Art. 20. NO SHIP UNDER ANY CIRCUMSTANCES TO NEGLECT PROPER PRECAUTIONS.—Nothing in these Rules shall exonerate any Ship, or the Owner, or Master, or Crew thereof from the Consequences of any Neglect to carry Lights or Signals, or of any Neglect to keep a proper Look-out, or of the Neglect of any Precaution which may be required by the ordinary Practice of Seamen, or by the Special Circumstances of the Case.

ADDENDA TO THE REGULATIONS FOR PREVENTING COLLISIONS AT SEA.

From the London Gazette, August 4th, 1868.

STEERING AND SAILING RULES.—Whereas there has been doubt and misapprehension concerning the effect of the two Articles 11 and 13.

Her Majesty, by virtue of the powers vested in her, and by and with the advice of her Privy Council, is pleased to make the following additions to the said Regulations by way of explanation of the said two recited Articles; that is to say:—

The said two Articles numbered 11 and 13 respectively only apply to cases where ships are meeting end on, or nearly end on, *in such a manner as to involve risk of collision.* They, consequently, do not apply to two ships which must, if both keep on their respective courses, pass clear of each other.

The only cases in which the said two Articles apply, are, when each of the two ships is end on, or nearly end on, to the other; in other words, to cases in which, *by day,* each ship sees the masts of the other in a line, or nearly in a line, with her own; and, *by night,* to cases in which each ship is in such a position as to see both the side lights of the other.

The said two Articles do not apply, *by day,* to cases in which a ship sees another *a-head* crossing her own course; or, *by night,* to cases where the red light of one ship is opposed to the red light of the other; or where the green light of one ship is opposed to the green light of the other; or where a red light without a green light, or a green light without a red light, is seen or where both green and red lights are seen but a-head.

RULE OF THE ROAD FOR STEAMERS,

WITH AIDS TO MEMORY, IN FOUR VERSES,

BY THOMAS GRAY.

1. TWO STEAM SHIPS MEETING :—

When all three Lights I see ahead—
I Port my helm, and show my RED.

2. TWO STEAM SHIPS PASSING :—

GREEN to GREEN—or RED to RED—
Perfect safety—Go a-head!

3. TWO STEAM SHIPS CROSSING :—

If to my Starboard RED appear,
It is my duty to keep clear;
Act as judgment says is proper—
Port—or Starboard—Back—or, Stop her!

But when upon my Port is seen
A Steamer's Starboard light of GREEN,
For me there's nought to do, but see
That GREEN to Port keeps clear of me.

4. ALL SHIPS MUST KEEP A GOOD LOOK-OUT, AND STEAM SHIPS MUST STOP AND GO ASTERN, IF NECESSARY :—

Both in safety and in doubt
I always keep a good look-out;
In danger, with no room to turn,
I Ease her!—Stop her!—Go astern!

SIGNALS OF DISTRESS.

In the day-time, whether used or displayed together or separately.

1. A gun fired at intervals of about a minute.
2. The International Code signal of distress indicated by N C.
3. The distance-signal, consisting of a square flag, having either above or below it a ball, or anything resembling a ball.

At night, whether used or displayed together or separately.

1. A gun fired at intervals of about a minute.
2. Flames on the ship (as from a burning tar-barrel, oil-barrel, &c.).
3. Rockets or shells, of any colour or description, fired one at a time at short intervals.

"Any Master of a vessel who uses or displays, or causes or permits any person under his authority to use or display any of the said signals, except in the case of a vessel being in distress, shall be liable to pay compensation for any labour undertaken, risk incurred, or loss sustained in consequence of such signal having been supposed to be a signal of distress, and such compensation may, without prejudice to any other remedy, be recovered in the same manner in which salvage is recoverable."—(*Merchant Shipping Act*, 1873.)

SIGNALS FOR PILOT.

In the day-time, whether used or displayed together or separately.

1. The Jack or other national flag usually worn by merchant ships, having round it a white border

one-fifth of the breadth of the flag, to be hoisted at the fore; or

2. The International Code pilotage-signal indicated by P T.

At night, whether used or displayed together or separately.

1. The pyrotechnic light, commonly known as a blue light, every fifteen minutes; or
2. A bright *white* light, flashed or shown at short or frequent intervals just above the bulwarks, for about a minute at a time.

"Any Master of a vessel who uses or displays, or causes or permits any person under his authority to use or display, any of the said signals for any other purpose than that of summoning a pilot, or uses or causes or permits any person under his authority to use any other signal for a pilot, shall incur a penalty not exceeding £20."—(*Merchant Shipping Act*, 1873.)

ROCKET AND MORTAR APPARATUS.

Instructions for the Guidance of Masters and Seamen when using the Apparatus for Saving Life, in Cases of Shipwreck.

In the event of your vessel stranding within a short distance of the United Kingdom, and the lives of the crew being placed in danger, assistance will, if possible, be rendered from the shore in the following manner; namely—

1. A rocket or shot, with a thin line attached, will be fired across your vessel. Get hold of this line as soon as you can, and when you have secured it let one of the crew be separated from the rest, and, if in the

daytime, wave his hat or his hand, or a flag or handkerchief; or, if at night, let a rocket, a blue light, or a gun, be fired; or let a light be displayed over the side of the ship, and be again concealed, as a signal to those on shore.

2. When you see one of the men on shore, separated from the rest, wave a *Red* flag, or (if at night) show a *Red* light, and then conceal it, you are to haul upon the rocket line until you get a tailed block with an endless fall rove through it.

3. Make the tail of the block fast to the mast about 15 feet above the deck, or if your masts are gone, to the *highest secure* part of the vessel. When the tail block is made fast, and the Rocket line unbent from the Whip, let one of the crew, separated from the rest, make the signal required by Art. 1 above.

N.B.—The tail block being fitted with a swivel will enable you to take out the turns (if any) in the endless fall, without unbending the block.

4. As soon as the signal is seen on shore a hawser will be bent to the whip line, and will be hauled off to the ship by those on shore.

5. When the hawser is got on board, the crew should at once make it fast to the same part of the ship as the tail block is made fast to, only about 18 inches higher, *taking care that there are no turns of the whip line round the hawser.*

N.B.—The turns can be prevented by bringing the end of the hawser up between the two parts of the endless fall.

6. When the hawser has been made fast on board, the signal directed to be made in Art. 1 above is to be
ted.

7. The men on shore will then pull the hawser taut, and by means of the whip line will haul off to the ship a sling, cot, or life-buoy, into which the person to be hauled ashore is to get and be made fast. When he is in, and secure, one of the crew must be separated from the rest, and again signal to the shore, as directed in Art. 1 above. The people on shore will then haul the person in the sling to the shore; and when he is landed, will haul back the empty sling to the ship for others. This operation will be repeated until all persons are hauled ashore from the wrecked vessel.

8. It may sometimes happen that the state of the weather and the condition of the ship will not admit a hawser being set up; in such cases a sling or life-buoy will be hauled off instead, and the shipwrecked persons will be hauled through the surf, instead of along a hawser.

Masters and crews of stranded vessels should bear in mind that *success* in landing them in a great measure *depends upon their coolness, and attention to the rules here laid down;* and that by attending to them, many lives are annually saved by the Mortar and Rocket Apparatus on the coasts of the United Kingdom.

The system of signalling must be strictly adhered to; and all women, children, passengers, and helpless persons should be landed before the crew of the ship.

THE LAW OF STORMS

AND ITS PRACTICAL APPLICATION TO NAVIGATION.

[The first part of the following notice of the *Law of Storms* appeared, almost as now reprinted, in the early editions of this work: it is valuable as giving the most succinct account we have of the labours of our countryman, Colonel (afterwards General) Sir William Reid, in a field of observation which was entirely new forty years ago. Recent research has only modified early views of the subject, but, from a practical point, many (perhaps most) of the rules and cautions as to handling a ship in a hurricane are as valuable to-day as they were when first enunciated by Colonel Reid.]

ONE of the most encouraging circumstances connected with the progress of science is the practical nature of its results. In former ages, science was studied more for the intellectual pleasure which it afforded to its professors than for the sake of benefiting mankind; and yet such is the inestimable value of every truth which has been fairly established, that it remains immortal through all ages, and can be applied to practical purposes when civilisation has sufficiently advanced to enable men to appreciate its value. Who could have supposed that the properties of the conic sections discovered by the Greek Geometers would have been of infinite service in modern times in renovating the science of Astronomy and perfecting the art of Navigation?—so that, as Condorcet well remarks, "the sailor who has been preserved from shipwreck by an accurate observation of the longitude, owes his life to a theory conceived two thousand years ago, by men ius who had in view only simple geometrical

speculations." And who, in our own day, could have supposed that a careful study of the motions of the wind during a hurricane would have ended in ascertaining the law which regulates its movements, thereby affording to the navigator a set of practical rules for guiding his ship out of the storm, and thus escaping the horrors of the tempest, and even of shipwreck?

It was commonly supposed that a gale of wind or a hurricane was sufficiently described when it was defined to be a wind moving in a straight course at the rate of 40 to 100 miles an hour.

The first observer who seems to have called in question this definition was Dr. Franklin. He had been prevented from observing an eclipse of the moon at Philadelphia by one of the north-east storms so common on the coast of America, and he was surprised to hear that the eclipse had been seen at Boston, although that town lay to the north-east of Philadelphia. On further inquiry he ascertained that the same north-east storm had not reached Boston until some hours after it had raged at Philadelphia, and that although the wind blew from the north-east, yet the progress of the storm was from the south-west. Franklin did not live to investigate the subject, but in 1801, Colonel Capper, of the East India Company's service, in a work on "Winds and Monsoons," gives some precise information on the nature of great storms. By a careful study of the phenomena of the great storms which swept over Pondicherry and Madras in 1760 and 1773, he arrived at the conclusion that hurricanes are gigantic whirlwinds of a diameter not exceeding 120 miles; that they have sometimes a progressive motion, and that ships might escape from their influence by taking advantage of the land wind. He also thought it possible to ascertain the position of a ship in a whirl

wind, by noting the force and changes of the wind, so as to enable the vessel to withstand its fury and escape from its vortex; for, "if the changes are sudden, and the wind violent, in all probability the ship must be near the centre of the vortex of the whirlwind; whereas, if the wind blow a great length of time from the same point, and the changes are gradual, it may be reasonably supposed the ship is near the extremity of it."

About the year 1831, Mr. W. C. Redfield, of New York, was by an independent series of observations led to a similar conclusion; namely, that the hurricanes of the West Indies, like those of the East, are great whirlwinds; that the whole of the revolving mass of air advances with a progressive motion from south-west to north-east; and hence he concluded that the direction of the wind at a particular place formed no part of the essential character of the storm, but that it was in all cases compounded of the whirling and progressive velocities of the storm. Mr. Redfield arrived at these conclusions by a careful study of the hurricanes of September, 1821, and August, 1830, and, having collated the accounts of the latter storm from more than seventy different localities, he laid it down on a chart, thus tracing it in a tangible form along the Atlantic coast.

This hurricane, after passing close by the Windward Islands, visited St. Thomas, one of the Virgin Islands, at midnight on the 12th of August, 1830; was near Turk Island on the 13th; at the Bahamas on the 14th; on the gulf and coast of Florida on the 15th; along the coast of Georgia and the Carolinas on the 16th; off Virginia, Maryland, New Jersey, and New York, on the 17th; off George Bank and Cape Sable on the 18th; and over the Porpoise and Newfoundland Banks on the 19th; terminating to the south of the

island of St. Pierre, in long. 57° W., and lat. 43° N. It performed this long journey of more than 3,000 miles in about seven days, at the average rate of about 18 miles per hour.* And the whirling body of air, thus advancing upon its central axis, was from 150 to 200 miles in diameter, within which the hurricane was severely felt; but a track of from 500 to 600 miles in width was more or less influenced by its action. The duration of the most violent portion of the storm, at the several points over which it passed, was from seven to twelve hours, and the rate of its progress from the island of St. Thomas to its termination beyond the coast of Nova Scotia varied from 15 to 20 miles per hour.

The rotative motion of this great whirlwind was from the left to the right hand of a person entering it; or from right to left of a person leaving it; or contrary to the sun's apparent daily motion, or to the hands of a watch lying with the face upwards. That this was the actual motion was proved by the varying directions of the wind at the different points of its track, as also by its action on two outward-bound European ships, the *Illinois* and the *Britannia*. On the 15th August the *Illinois* experienced the swell which preceded the hurricane advancing from the south; but as the ship had a fair wind, and was impelled by the Gulf Stream, while the storm lost time by making a bend towards Charleston and the coast of Georgia, the ship outran the swell; but on the 17th she was overtaken by the storm blowing furiously from *south;* while at the same moment it was tearing off the roofs of houses at New York, blowing from *north-east*. The *Britannia*, which

* In the records of various storms, the progressive movement has been found to vary from 43 to 3 miles an hour; and there is reason to think that storms sometimes move still more slowly, particularly between the tropics and lat. 30°, where they change their direction.

left New York in fine weather on the 16th, met the hurricane on the night of the 17th, having the wind first at *north-east*, then *east-north-east*, and after midnight from *south-east*.

Mr. Redfield projected on a chart the track of five great rotatory storms, collecting his data for the purpose from the various accounts given in the places over which the storms passed during the first and most destructive part of their progress, or before they reached the latitude of 35° N. One of these tracks is the hurricane which desolated Barbadoes on the night of the 10th August, 1831. On the 11th it passed over the islands of St. Vincent and St. Lucia, extending a portion of its influence to Martinique and the neighbouring islands on the north, and to Grenada on the south, but exhibiting its principal violence between 12° 30′ and 14° 30′ N. latitude. On the 12th it arrived on the southern coast of the island of Porto Rico. From the 12th to the 13th it swept over the island of St. Domingo, and extended its influence as far southward as Jamaica. On the 13th it raged on the eastern portion of Cuba, sweeping in its course over large districts, if not the whole, of that extensive island. On the 14th it was at Havana, towards the west end of that island. On the 15th the gale was encountered off the Tortugas. On the 16th and 17th it arrived on the northern shores of the Gulf of Mexico, in about the 30th degree of north latitude, raging simultaneously at Pensacola, Mobile, and New Orleans, where its effects were continued till the 18th,—thus having occupied a period of six days, or about 150 hours, in its passage from Barbadoes to New Orleans, a distance of 2,300 statute miles, equal to about 16 miles an hour. The rotative character of this storm was well shown in the effects which it produced at Barbadoes. The trees which it uprooted near the

northern coast lay from N.N.W. to S.S.E., having been thrown down by a northerly wind in the earlier part of the storm; while in the interior and some other parts of the island they were found to lie from south to north, having been blown down in the latter part of the gale. From the coast of the Gulf of Mexico the storm entered upon the territories of the adjoining States, where it spent itself in heavy rains.

Mr. Redfield remarks that when accounts of hurricanes were formerly received, as occurring at different islands on various dates, with marked differences also in the direction of the wind, it was taken for granted that those violent winds were rectilinear in their course, and that such accounts related in most cases to different storms. It is now discovered, however, that there is no difficulty in tracing these storms successively from one island or locality to another, and the direction of the wind at any one point or place is found to have no connection with the general progress or direction of the storm. For example, at most of the islands over which the hurricane just noticed passed, the winds in the earlier part of the storm were from a northern quarter, and in its later periods from a southern quarter: whence it appears that the rotative action was from right to left, regarded from the centre, or from left to right, if viewed from without, as in the storms which pass to the northward of the great islands and along the Atlantic coast.

On examining the chart in which these storms are laid down, it is impossible not to be struck with the symmetrical character of the curve which describes their track: the track in each case appears to form part of a hyperbola, and the vertex or turning point of the curve is uniformly found in or near the 30th degree of latitude. And it may be noticed, in connection with

this fact, that the latitude of 30° marks the external limit of the trade-winds on both sides of the equator.

We must now refer more particularly to the labours of another gentleman in this useful field of inquiry. Colonel Sir William Reid,* of the Royal Engineers, having been sent to the island of Barbadoes in the year 1831, on military service, his attention was first directed to the subject of these hurricanes from having been employed to re-establish the Government buildings which had been blown down in the hurricane of that year. He made diligent inquiry for accounts of previous storms, with a view to ascertain something of their causes and mode of action, but found little beyond a record of the losses in lives and property, and the sufferings of the inhabitants during the periods of these tempests. Having, however, met with Mr. Redfield's papers, he determined to verify the results obtained by that gentleman, by making charts on a large scale, and on these laying down the different reports of the wind at points given in those documents. The more exactly this was done, the nearer appeared to be the approximation to the tracks of a progressive whirlwind. In two works published by Colonel Sir William Reid on this subject,† he gave these charts, together with a number of others founded on data collected by himself. With great industry and perseverance, he succeeded in procuring

* We preserve throughout the title of "Colonel" in preference to any other, as that under which his works were published, and best known.

† (1) "An Attempt to develop the Law of Storms by means of facts, arranged according to place and time; and hence to point out a cause for the Variable Winds, with the view to practical use in Navigation. Illustrated by charts and woodcuts." By Colonel Sir W. Reid, C.B., F.R.S. (of the Royal Engineers). Second edition, with additions. London.

(2) "The Progress of the Development of the Law of Storms and of ⁱable Winds," &c. By the same. London.

the log-books of numerous ships, and the information conveyed by them he combined with that obtained on land, thus comparing simultaneous observations over extended tracks.* For example, in one chart he points out eight ships in several positions in the same storm, the tracks of several of them crossing the path of the storm, the wind as reported by the ships being corroborated by the reports from the land. The observations of ships possess a great advantage for this kind of research, because in merchant ships the log-books report the weather every two hours, and ships of war have hourly observations.

From observations made during his residence in the islands of Barbadoes and St. Vincent, Colonel Sir William Reid came to the conclusion that the progressive rate of the storms is not greater than that of the atmospheric currents, and that hurricanes owe their destructive power to their rotatory velocities. It would be quite impossible, in our limited space, even to notice the great storms whose history has been minutely written down in his two works on the subject. All we can hope to do is to give a brief statement of the practical rules for the management of a ship in these storms, so as to be able to get beyond their influence, instead of sailing into them, and being exposed to their fury. But as those rules refer to the navigation of a ship in either hemisphere, it is necessary to notice a peculiarity in the storms of the southern hemisphere.

In the northern hemisphere, the typhoons of the Chinese seas seem to differ in nothing but name from the hurricanes of the well-frequented seas of the Western

* He even went back to the records of the great hurricanes of the years 1760-1, 1780, 1808, 1809, 1811, 1818, 1819, 1824, 1834, and 1836. In the later volume some of the practical advantages derived from the volume first published are exhibited.

Atlantic, which have hitherto engaged our attention. They rotate in the same manner, contrary to the hands of a watch; they appear to originate in the same latitude, and to travel in the same directions—at first north-westward, till they arrive at the northern limit of the trade-wind, and then turning north-eastward. These storms occur during both monsoons; but are most violent during the months of June and July.

Having thus ascertained the law of these storms in the northern hemisphere, it was natural to inquire whether similar storms do not originate in the southern trade-wind. It is a remarkable circumstance that the South Atlantic is never visited by hurricanes. Ascension and St. Helena are situated in the midst of the southern tropical current, but storms are unknown at these places; while at Mauritius, nearly in the same latitude, but on the opposite side of Africa, storms are frequent and destructive. By comparing the logs of various ships, Colonel Sir William Reid constructed charts of some of these hurricanes of the Indian Ocean; and their curved tracks present the same hyperbolic form as those already described, having the vertex or turning point at the same latitude, about 30°: but these storms being in the southern hemisphere, travel along their curve from its northern to its southern extremity, exactly contrary to those in the northern hemisphere, though describing the same figure; and it is interesting to notice that their whirling motion is also reversed, being similar to that of the hands of a watch—a result which might naturally be expected from their common origin, whatever that may be.

An examination of the charts in Colonel Sir William Reid's volumes therefore shows that these great storms originate in the trade-winds, frequently, perhaps always, with the most violent ones, at the equatorial side of

each of those great currents, where they strike on the central region of calms. The motion of these great rotatory storms is always in a direction contrary to the sun's apparent daily motion, and therefore, in our hemisphere, contrary to the motion of the hands of a watch, but similar to that motion in the southern hemisphere. The general progress of these storms is always away from the equator, and therefore reversed in the two hemispheres: but in both cases they have first a westward motion, till they escape from the influence of the easterly trade-winds, when they turn round in a hyperbolic curve, and are drifted eastward by the prevailing westerly winds of each temperate zone. Throughout their course they increase in size, till they are lost in the winds of high latitudes, the variable and fluctuating nature of which they greatly increase. "The farther we go from the equator," says Colonel Sir William Reid, "the more complicated this subject becomes; and gales succeed each other so fast during our stormy season, that it is not easy to identify the particular storm we may wish to study. It has been shown that the hurricanes which originate within the tropics increase in diameter and diminish in force as they proceed towards the poles; and as the meridians approach each other, the gales may become huddled together. They may, therefore, frequently neutralise each other, and become irregular.* Their force, too, may often fall off,

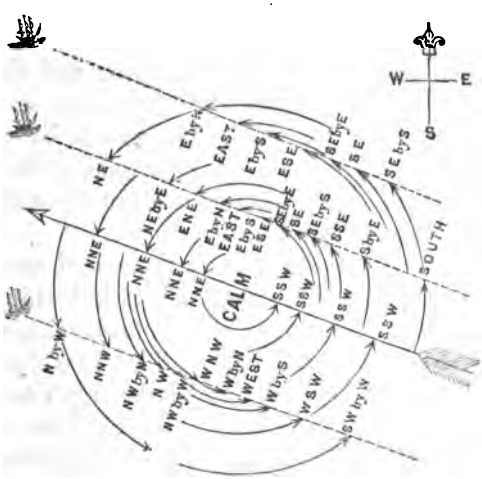
* Recent investigation shows that such storms often invade high northern latitudes. In the storm of February 28, 1849, Mr. Milne showed that "its centre passed in a N.E. direction up the Irish Channel and across the south of Scotland; its eastern segment affected severely the south of England, uprooting large trees and causing wrecks, one of which was of an emigrant ship with 160 passengers. Its effects were not so disastrous in Scotland, but its rotatory character was well developed there. At the Observatory on Calton Hill at Edinburgh the gale began with the wind at S.S.E., and it veered round successively to S., S.W., W., and N.W. On the

until the strength of the wind on that side of the circle where it blows from east is unable to reverse the regular westerly atmospheric current, and to convert it into a temporary easterly gale; and this may be a reason why easterly storms are less frequent in both hemispheres in the latitudes within which Great Britain is situated."

Before any rules for the guidance of the navigator can be properly appreciated, it is necessary to gain as precise an idea as possible of the nature of these great storms, for which purpose the following figure (p. 139) may assist the reader. It is supposed to represent a rotatory storm in the northern hemisphere, revolving in the direction of the curved arrows, while it travels forward in the direction of the large straight arrow, or from E.S.E. to W.N.W.; and if we suppose it to pass over three different ships, situated at different distances from its central track, the effect on them will be the same as if the whirlwind had no progressive motion, and they travelled through it from W.N.W. to E.S.E. along the three dotted lines parallel to the large arrow, but in the opposite direction thereto. By following either of these lines, it will be seen that the wind will blow in succession from the various points marked on each dotted

same day it was blowing—at Kinnaird Head and Buchanness from S.E.; at Montrose from S.S.E.; at Edinburgh from S.; in Yorkshire from S.W.; at Pladda lighthouse from W.N.W.; at Corsewall lighthouse from N.W.; at Skerryvore lighthouse from N.; at Glass Island lighthouse from N.E.; at Pentland Skerries lighthouse from E." "There could be no doubt, therefore," adds Mr. Milne, "that this was a whirlwind storm, and that the direction of rotation was from right to left in the northern half of the circle." Sir William Reid also noticed a severe Atlantic storm which passed over the British Islands. It first touched the West coast of Ireland on January 6, 1839, and moved progressively, about E.N.E., over Ireland, the Irish Channel, and Great Britain. It was traced to Gottenburg, in Sweden, and this is the same direction taken by many of the storms which have been traced over North America and the Western Atlantic.

line. For example, the gale experienced by the northernmost ship will begin at E. by N. and veer through six points to S.E. by S. at the end of the storm. The southernmost vessel, being nearer the central track of the storm, will have the wind veering through ten points, beginning at N. by W. and ending at S.W. by W.; while the middle ship, being still nearer the centre of the storm, will have the wind first at N.E., and veering through twelve points until



it finishes at due South. By observing the distances between the several arrow-heads on either of these lines, especially the last, it will be seen that they thicken towards the middle of the line, showing that the veering of the wind is most gradual on entering and quitting the storm, and most rapid the nearer the centre. But the farther a vessel is from the central track the less will this difference be observed: for example, on the northernmost line, in the figure above, the arrow-heads are more nearly equidistant, showing that the change of

wind is more equable, or nearly as gradual at the middle of the duration of the storm as at its beginning or end.

It will also be observed that the number of points through which the wind veers will be greater the nearer the ship approaches the centre of the storm; but this number can never exceed fifteen, for when a ship is exactly in the central track she will experience no veering, but a constantly increasing gale from one point (in this case N.N.E.), and then a sudden change to the opposite point (S.S.W.); this is a part of very great danger, owing to the sudden change from a violent wind to a perfect calm with a turbulent sea; and the calm have passed onwards with the storm, the ship must be prepared for the equally violent gale to be expected from the opposite point. In approaching this space the mercury in the barometer continually sinks, and rises again in receding from it.

Rules have been drawn up for the use of seamen, to enable them to determine on which tack a ship should be laid-to in any storm of this kind, in either hemisphere and in any part of the world. The object is to prevent the wind from veering by the ship's head, and to insure its veering constantly farther aft, so that she may be constantly *coming up* to the wind, whereas in the former case she would be *breaking off* from the wind, and, even with no sail set, would in so violent a gale be in danger of being driven astern. Colonel Sir William Reid supposed this might have been the cause of many vessels foundering. The avoidance of this danger depends on determining whether the vessel be on the right or left of the central track of the storm.* There

* Right and left are here used with reference to the storm's progressive motion, in the same manner as we speak of the right and left banks of a river as we look in the direction in which the water is

is not much difficulty in determining this point if we observe the manner in which the wind begins to veer; for on referring to figure (p. 139) it will be seen that at all places over which the right-hand half of the storm passes, the wind veers with the sun, or from east to south, or from left to right of the observer, while at all places under the influence of the left-hand semicircle of the storm the wind veers in the contrary direction, or against the sun; and this will be the case in whatever direction the storm may be travelling, and in whichever way it may be rotating; so that in the storms of the Indian Ocean, or in storms of the southern hemisphere, although rotating the contrary way to this, a veering of the wind from the right to the left of the observer will equally indicate that he is at the left side of the storm, and *vice versâ*, although in that hemisphere the expressions "with the sun" and "against the sun" will have their meaning reversed.

Now it has been shown by Colonel Sir William Reid, that in both hemispheres alike, a vessel finding herself at the *right* side of the storm should be laid-to on the *starboard* tack, and when in its *left* side on the *port* tack, to avoid the danger of the wind veering ahead. In this way she will *come up* to the wind instead of *falling off* from it. In some cases, however, should the ship forge ahead, she will draw towards the storm's central track. "It may, therefore, be preferable, as a general rule, when heaving-to in a revolving gale, to bring the ship to the wind on the starboard tack when on the north side of the equator, and on the port tack when on the south side of the equator. Then will the ship, when shooting ahead, be gradually moving away from the storm's centre."

It has sometimes been advised that a vessel should always scud before a hurricane. Colonel Sir William

Reid shows that although there is one quadrant of the storm in which scudding will tend to carry the ship beyond its influence, yet, in the opposite quarter, scudding will be especially dangerous, as tending to carry her across the storm's track and towards the centre. This will clearly be the case in the forward half of the right-hand semicircle of a storm in our hemisphere, or in the forward half of the left-hand semicircle of a storm in the Southern Indian Ocean. But if, instead of thus dividing the storm by a line parallel to its progress, we divide it by a line at right angles to its course, or into the advancing and receding halves, it will be seen that a vessel in the advancing half of the storm runs far greater danger of being exposed to all its fury, and for a longer time, than one which enters its receding half. The most dangerous quadrant, therefore, is that which belongs to the advancing right-hand semicircle in the Northern hemisphere, and the advancing left-hand semicircle in the Southern hemisphere; and Colonel Sir William Reid shows that vessels have most frequently been lost, as far as can be ascertained, in this quarter of the storm. In the storms of both hemispheres, therefore, during the first part of their course, or in the Trade-winds, this quadrant of greatest danger is on the side farthest from the equator; but during their latter course, after they have left the Trades, it is in both hemispheres alike, on the eastern side of the storm.

These rules would be comparatively easy in their application if the course of the storm were nearly straight; but they become difficult when the storm is sweeping round the most curved part of its track, usually about lat. 25° or 30°, where the ship might be involved twice in the vortex. It is at this particular part of their track that hurricanes have produced the

most fatal effects at sea; and hence it is that the most dreaded part of the Atlantic is near the Bahamas and Florida; and that of the Indian Ocean to the southward of the islands of Mauritius and Reunion.

For the assistance of seamen, in the practical application of the theory of revolving winds, circles have been published, showing how the gales revolve in either hemisphere. They are printed on talc, or on paper made transparent by being dipped in turpentine, and when placed on a chart, they serve to aid the memory while considering how the wind veers in whirlwind storms.

In some parts of the ocean *water-spouts* or *whirl-pillars* are occasionally met with. They are alarming to persons who witness them for the first time, for the broken water makes a great noise when a ship is passing near them by night. Horsburgh says that "in calm weather they are seen approaching from a distance, and in the night their noise is heard a considerable time before they come near: they beat against the sides of a ship with great violence, and pass on, the spray sometimes coming on deck, and a small boat could not always resist the turbulence of these remarkable ripples." Captain Basil Hall remarked that when the ship got completely within the circuit of the ripple, the wind uniformly freshened, and that upon watching the phenomenon it was distinctly made out that at the same time a change occurred in its direction. Colonel Sir William Reid has also, from his own observations, connected the ripple with the whirl-pillar: while observing a portion of the sea during a calm, agitated in this manner, with a small dense cloud immediately over it, he watched them earnestly, when, after twenty minutes, a small water-spout was distinctly developed from the cloud, and was seen suspended over

the ripple. He has also observed whirl-pillars in a perfectly cloudless sky. As these whirl-pillars are small whirlwinds, they may cause unexpected shifts of wind dangerous to ships: it is therefore necessary for the seaman to be on his guard whenever he notices them.

Of a totally different character from these ripples are the swells and great waves which are raised by rotatory storms. These great undulations of the sea probably conform to the same law as that which prevails in rotatory storms, and change their direction according to the changes of the wind within the storm's area. Colonel Sir William Reid supposed these undulations to be raised along the radii of the whirlwind circle, and to roll onwards in a straight line, in the direction of tangents to the circle of the whirlwind. In this way waves would be propagated in all directions within its circuit, and, to some extent, beyond it there would be a cross sea. The undulations thus produced sometimes roll to a very great distance. "The waves propagated by the Barbadoes hurricane of 1831 broke against the southern shore of the Bermudas. The swell raised by a revolving winter storm, passing over the Bahama and Bermuda Islands on the 30th January, 1845, endangered the *Eurydice* frigate, at anchor in the harbour of St. John's at Antigua, although the wind at Antigua was light at the time."

Colonel Sir William Reid says: "I was at Bermuda when the hurricane of 1839 occurred, and distinctly heard the sea breaking loudly against the south shores on the morning of the 9th September, full three days before the storm reached the islands, as recorded in tables of the state of the weather kept at the Central Signal Station. At that time the hurricane was still within the tropic, and distant 10° of latitude. As the storm approached, the swell increased, breaking against

the southern shores with louder roar and great grandeur until the evening of the 12th of September, when the whirlwind storm, reaching the Bermudas, set in there. When the storm had passed over the Bermudas, the southern shore became calm, and the northern reefs, in their turn, presented a white line of surge, caused by the undulations rolled back from the storm in its progress towards Nova Scotia and Newfoundland. . . . I think it probable that the heaviest swell proceeding from a storm may be that which is propelled forward in the track which the storm is itself following, as the undulations in this case would be constantly receiving renewed impulses from the storm in its progression. This may account for the unusal degree of grandeur with which the undulations broke against the southern shores of the Bermuda Islands, just before the storm set in there."

It has not unfrequently been remarked by many shipmasters that by carefully observing the set of the swell previous to and even after the commencement of the storm, a tolerably correct idea may be formed of the direction the wind is likely to take. Colonel Sir William Reid also remarks that on the outer circuit of a gale the change in the direction of the swell seems to precede the change of wind; but at the centre of a progressive whirlwind, when the rate of progression is rapid, and the shifting of the wind sudden, the wind often changes faster than the swell. The muddy appearance of the water of the sea in anchoring depths, during violent storms, sometimes precedes the storm, being caused by heavy undulations affecting the bottom of the sea.

Colonel Sir William Reid and Mr. Milne have also suggested the probability that the diminished atmospheric pressure which accompanies progressive revo-

ing storms might create ocean currents. "If," says the former authority, "a revolving power, like a whirlwind, were the only one exerted, it might be expected that the level of the water would be diminished at the centre of the vortex, though heaped up towards the verge of the storm. But it may be possible that a wave of a round or oval form, moving onward like a tidal wave, but at the rate of the storm's progress, may accompany the storm in its course, and that its height may depend on the degree of diminished atmospheric pressure, modified by the revolving power of the wind. The impulse in the direction of the storm's course being given, and maintained for a few hundred miles, currents, very similar to the ordinary currents of the tidal wave, might be created; so that, if the effect produced by such a wave is added to a spring-tide, it might assist in causing those inundations in flat lands which often occur in violent storms."

Since the time when this theory was proposed in the second edition of Colonel Sir William Reid's earlier work, accumulated evidence has established its truth; and, indeed, the whole subject of the law of storms is now rapidly approaching a perfection which promises to be of infinite service to the navigator in every part of the world.

The influence of these storms upon the atmospheric pressure has already been alluded to. A whirlwind which sets an extensive portion of the atmosphere in a state of rapid revolution causes a diminution in pressure over that portion of the earth's surface, and most of all at the centre of the whirl, because at the centre the depth of the compressing column of air will be least, and its weight will be diminished in proportion to the violence of the whirl. It sometimes happens in these gyrations that the mercury in the barometer sinks

as much as two inches, thus diminishing the atmospheric pressure by $\frac{1}{15}$th part. As a consequence of this, cold air is brought down from the upper regions of the atmosphere, and this, mingling with the warmer and moister air of the sea, forms very dense clouds. "In the northern hemisphere within the tropic, the barometer usually falls with a northerly wind, because whirlwinds come from the eastward. But in the southern hemisphere within the tropic, the barometer usually falls with a southerly wind, because, although whirlwinds there also come from the eastward, they revolve in a contrary direction, south of the equator. In both hemispheres, revolving gales blow with a west wind on the side next the equator. In recurving in both hemispheres, whirlwind storms will have a polar direction for a while. The barometer, during that time, will begin to fall with easterly winds; but after they have recurved, and are moving easterly, the barometer will fall with southerly winds in the northern hemisphere, and with northerly winds in the southern hemisphere." There may, however, be exceptions to these general rules. "Ships at sea may sail into whirlwind gales at any point in their circumference; and they not unfrequently overtake storms in their course by sailing faster than these move along." Moreover, these storms have not always an easterly progression in high latitudes, and they become more or less irregular on coming in contact with hills and valleys on land, as already noticed.

To show the value of attending to the indications of the barometer at sea, we will state briefly the facts of a case in which Capt. J. V. Hall avoided falling into the heart of one of these gales or typhoons of the China Sea. When three or four days' sail from Macao, about noon, Captain Hall observed "a most wild and uncom-

mon-looking halo round the sun." Next day set in with light squalls, smooth water, but strong ripples. The afternoon was remarkably fine, but the barometer had fallen considerably since noon. About 3 P.M. it was still falling; and although the weather was very fine, orders were given to strike the sails, and to clear the rigging of everything that could be spared: the boats were also hoisted on board, and well secured. Towards evening, a bank was observed in the S.E. Night closed in, and the water continued smooth; but the sky looked wildish, the scud coming from the N.E., the wind from North. "I was much interested in watching for the commencement of the gale, which I now felt sure was coming; and considering the theory to be correct, it would point out my position with respect to its centre. That bank in the S.E. must have been the meteor [storm] approaching us, the N.E. scud the outer north-west portion of it; and when at night a strong gale came on about N. or N.N.W., I felt certain we were on its western and southern verge. It rapidly increased in violence; but I was pleased to see the wind veering to the N.W., as it convinced me that I had put the ship on the right tack, namely, *on the starboard tack*, standing, of course, to the S.W. From 10 A.M. to 3 P.M. it blew with great violence; but the ship, being well prepared, rode comparatively easy. The barometer was now very low, the wind about W.N.W., the centre of the storm passing, doubtless, to the northward of us, and to which we might have been very near, had we in the first part put the ship on the port tack, and stood to the north-east and towards the centre, instead of on the starboard tack, and to the south-west, the opposite direction. About 5 P.M. wind at W.S.W., sensibly decreasing, the barometer rising. At 6, fresh gale; made sail to keep

ship steady: a very great sea on, and towards midnight it became a moderate gale. The wind having now become S.W. to S.S.W., the ship broke off to S.E. Thinking it a pity to be lying so far out of our course, I wore to N.W., and made sail; but in less than two hours heavy gusts came on, and our barometer began again to fall. I now thought, of course, we were approaching the storm again. I wore again to the S.E.; and to show more clearly how great a difference a very short distance nearer to or farther from these storms makes, the weather rapidly improved. The next morning it was fine and moderate, and the wind became S.E. with a heavy running westerly swell. Until the afternoon, there was a dark, wild appearance to the westward, which seemed to me another proof that it was the meteor which had the day before appeared in the S.E., and whose course had been from S.E. to N.W., passing a little northward of our position."

There are many other interesting points which might be noticed, did the narrow limits of this Essay permit. We may, however, quote the following simple practical result of observation, namely, "that when ships meet a whirlwind gale, and are sailing towards its centre, *north* of the equator, they always have the wind on the ship's port-side; and when ships meet a whirlwind gale *south* of the equator, and are sailing towards its centre, they always have the wind on the ship's starboard-side." "But when the first part of a revolving gale is overtaking a ship, it will be otherwise; for then the ship would be as if sailing from the storm's centre. This would be the relation of the ship to the wind, until the storm's centre had passed beyond the ship's place, after which the ship would be as if pursuing the gale."

RECENT RESEARCHES IN THE LAW OF STORMS AND SUMMARY OF RULES.

Franklin had perceived that the views prevalent in his day respecting the nature of storms and hurricanes could not be correct; but he did not make much progress towards developing anything better. Subsequently Capper, from observations in the East, published many sound and suggestive notions on the subject; but Redfield, Reid, Thom, and Piddington were really the first investigators and luminous expositors of what has since come to be known as the *Law of Storms*. They took ships' logs and barometers into their confidence—both very imperfect and inaccurate data in those days on which to found a theory—and they eventually succeeded in discovering that every hurricane and great storm had a central spot of very low pressure, where there was a calm, and around which the winds were blowing with varying but intense strength; that the general direction of the wind was against the motion of watch hands in the northern hemisphere, but with watch hands in the southern hemisphere; that there was also a progression of the storm area; and that the pressure increased towards the outer verge of the storm. These things being determined, they gave their attention to showing how ships might best avoid the worst and most destructive parts of the hurricane.

But it must not be supposed that they were devotees of the *circular theory*—of *the wind blowing in circles returning on themselves*—and *of the centre being eight points from the direction of the wind*, such as has been the teaching of the last thirty years: all this they repudiated, and Colonel Reid distinctly states that if a circle represented a whirlwind correctly when station-

ary, "in the progressive whirlwind the figure would become cycloidal, and the degree of curvature would depend upon the rate of progress of the storm;" he also remarks that "in attempting to lay down a storm's track, a wrong judgment may be formed if data be rejected on account of its not conforming to a figure exactly circular;" but that *circles were found to be the most convenient figures in endeavouring to explain the nature of storms:* nothing more—and Redfield, Thom, and Piddington were equally opposed to the strictly circular theory.

When our elder cyclonists propounded the law of storms they had little idea that they had in reality discovered the law of the winds everywhere and always; that no strong wind blows in any part of the world but what is of the type of the cyclone; that the wind in the tropical hurricane may *at times* develop greater force and velocity than extra-tropical storms, but that they are all of one character—both as regards the rotation of the wind, and the progression (bodily) of the area of low pressure; thus they paved the way for the advanced theories of Dové, and for the later exposition of the law of the wind in relation to the distribution of atmospheric pressure as enunciated by Galton and Buys Ballot.

Spiral Rotation of the Wind.—As the result of careful research, modern meteorologists, almost without exception, recognise the spirally incurving tendency of the wind as its most probable behaviour in a storm; *the circulation being around and* at the same time *more or less towards the centre of least pressure,* which is usually characterised by a calm. The direction in which the winds move round this centre is—in the northern hemisphere from right to left (against the sun), or contrary to the motion of the hands of a watch,—but

in the southern hemisphere from left to right (also against the sun, in that hemisphere), or with the hands of a watch; both depending on the same cause—viz., the rotation of the earth on its axis in its effect on the winds as they pass from lower to higher latitudes, or *vice versâ*. The old rule of the circular theory is consequently only partially correct: when facing the wind the centre is not eight points to the right of its direction in the northern hemisphere, and to the left of its direction in the southern hemisphere: it is more nearly ten points, and may be more—the indraught being from two to three points, as shown on p. 153, where the dotted circle indicates the amount of indraught.

(*Note.*—The figures show at once the rotation of the wind in each hemisphere, and its direction in any part of the storm: the outer letters give the points of the horizon, and the inner letters the wind's direction.)

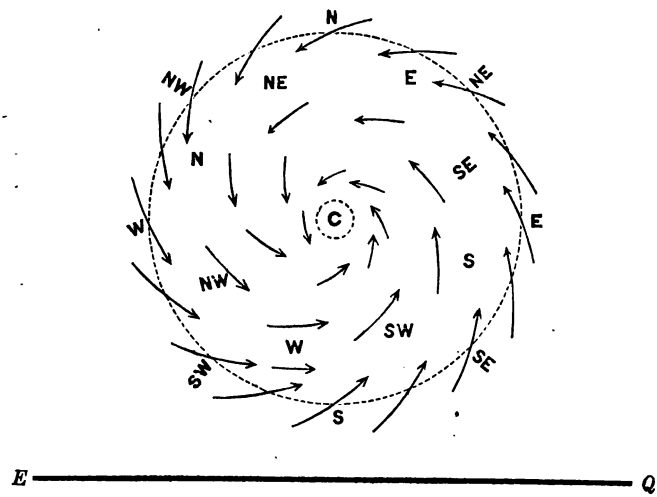
The *deduction from the order of rotation* is that, in the *Northern* hemisphere, on the *northern margin* of the storm the wind will be *easterly;* on the *eastern margin, southerly;* on the *southern margin, westerly;* and on the *western margin, northerly* (see upper fig. p. 153).

But, in the *Southern* hemisphere, owing to the reversion of the rotation, on the *northern margin* of the storm the wind will be *westerly;* on the *western margin, southerly;* on the *southern margin, easterly;* and on the *eastern margin, northerly* (see lower fig. p. 153).

In both hemispheres *westerly winds* are *characteristic of the equatorial side* of the storm; and *easterly winds* of the *polar side.*

The *Diameter of a tropical cyclone* or hurricane varies considerably during its progression; it is generally very small at its origin, expanding as it moves forward through the tropic, and as it expands breaks up. Some [illegible] been estimated to extend from 50 to 500 or 800 [illegible]across.

Figure illustrative of the Spiral Rotation of the Wind in the *Northern Hemisphere.*



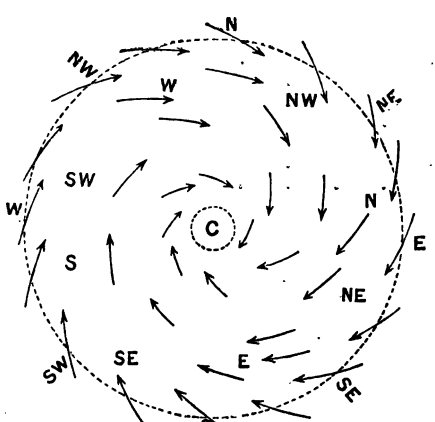


Figure illustrative of the Spiral Rotation of the Wind in the *Southern Hemisphere.*

The area of lowest pressure, near which the winds are presumably destructively strong, and where, to a ship deeply involved within the storm's area, the veering of the wind must be most rapid, is the special spot to avoid; and recent investigations give us the following *Rule for determining the centre of the storm* as more probable than that deduced from the circular theory;—*Face the wind*, and then—

In the Northern Hemisphere,—

Wind.	*Bearing of Centre.*
North	E.S.E., or more Southward.
N.E.	S.S.E., or more Southward.
East	S.S.W., or more Westward.
S.E.	W.S.W., or more Westward.
South	W.N.W., or more Northward.
S.W.	N.N.W., or more Northward.
West	N.N.E., or more Eastward.
N.W.	E.N.E., or more Eastward.

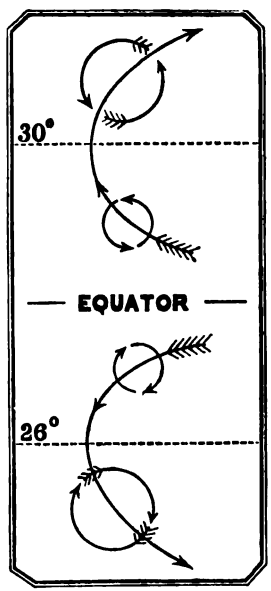
In the Southern Hemisphere,—

Wind.	*Bearing of Centre.*
North	W.S.W., or more Southward.
N.W.	S.S.W., or more Southward.
West	S.S.E., or more Eastward.
S.W.	E.S.E., or more Eastward.
South	E.N.E., or more Northward.
S.E.	N.N.E., or more Northward.
East	N.N.W., or more Westward.
N.E.	W.N.W., or more Westward.

The indraught is probably greater in one quarter of the hurricane than in another; and the *greater incurvation of the winds in front of a depression* is frequently noticed; also, the indraught may possibly be greater near the centre than farther from it.

Progressive Movement.—All storms have a progressive movement. Thus, the West Indian hurricanes commence a few degrees north of the equator, and then take a north-westerly route towards the northern

tropic; the track is more northerly as the tropic is approached, and subsequently the trend is north-eastward (*see* upper part of annexed diagram).



The Mauritius hurricanes also commence in the vicinity of the equator, but travel, first, south-westward, then southward near the southern tropic; and finally south-eastward (*see* lower diagram).

These storms, as indicated by the large arrows, are said to recurve in the vicinity of (generally on the polar side of) the tropics. But some storms seldom or never recurve: thus the cyclones of the Bay of Bengal move, according to the season, from East to West, or from S.S.E. to N.N.W. The typhoons of the China Seas are of both types. Storms also traverse the northern part of the North Atlantic, from W.S.W. to E.N.E., and even more Northerly, without having recurved. Similarly, storms in the Great Southern Ocean travel E.S.E. and S.E. ward: the result of areas of low pressure forming, passing onward, amalgamating, and then finally dispersing.

Our knowledge of the rate of progressive movement of storms is still very small. Some travel only 10 to 20 miles a day, others, perhaps, from 50 to 60 miles; but the rate of progressive movement has no necessary connection with the force of the wind.

The *Storm Track*, as indicated by the large arrows in diagrams p. 155, *divides the storm into two semicircles*, and looking in the direction of the progressive movement the *right-hand semicircle* in the *northern hemisphere*, but the *left-hand semicircle* in the *southern hemisphere*, is the *most dangerous*, because the most difficult one in which to manœuvre, so as to avoid the centre. The shift of wind will generally indicate in what part of the storm you are.

Combining the Rotatory with the Progressive Motion some very valuable Rules may be deduced whereby to indicate the part of the storm which is passing over a ship.

In the Northern Hemisphere:

In the *right-hand semicircle*, storm moving N.W.-ward (or *before recurving*), the *wind* hauls *with* (or in the same direction as) the apparent course *of the sun*, hence from N.E.-ward through East to S.E.

In the *right-hand semicircle*, storm moving N.E.-ward (or *after recurving*), *wind* hauls *with the sun*, hence from South and S.W. through West to N.W.

In the *left-hand semicircle*, storm moving N.W.-ward, the *wind* hauls *against* the apparent course *of the sun*, hence from North and N.W.-ward through West to S.W.

In the *left-hand semicircle*, storm moving N.E.-ward, *wind* hauls *against the sun*, hence from S.E. and E. through N.E. to N.

In the Southern Hemisphere:

In the *right-hand semicircle*, storm moving S.W.-ward (or *before recurving*), the *wind* hauls *against* the apparent course *of the sun*, hence from South and S.W. through West to N.W.

In the *right-hand semicircle*, storm moving S.E.-ward (or *after recurving*), *wind* hauls *against the sun*, hence from N.E.-ward through East and S.E. to South.

In the *left-hand semicircle*, storm moving S.W.-ward, the *wind* hauls *with* the apparent course *of the sun*, hence from S.E.-ward through East to N.E.

In the *left-hand semicircle*, storm moving S.E.-ward, *wind* hauls *with the sun*, hence from North and N.W. to West.

In either hemisphere, and near the tropic, if the wind hangs from the *Eastward*, suspect the storm as about to recurve.

On the Use of the Barometer in a Cyclone.—It was long ago remarked by Piddington, that "he who watches his barometer, watches his ship." This invaluable instrument invariably announces the approach of a storm,—shows whether the vessel is plunging into or receding from it; and hence, by carefully noticing its indications, the disastrous consequences of a hurricane may, to a great extent, be avoided—for the laws of its oscillations are very distinctly marked. Between the tropics its oscillations are so regular that any sudden fall of the instrument indicates the approach of a hurricane, even though all atmospheric and oceanic appearances of its proximity are at first absent. Beyond the tropics, the oscillations are incessant and irregular, but a continuous fall of the instrument, with a wind increasing in force, indicates that you are already in a cyclonic area. The barometer often stands unusually high before the commencement of a cyclone, and frequently (if not always) just *around* the storm; and conceiving the cyclone to be divided

into two parts by a diameter at right-angles to its path, it may be noted that in both hemispheres—

The barometer always *falls* during the passage of the *advancing* semicircle of a storm; and—

Always *rises* during the passage of the *receding* semicircle of a storm.

If purposing to take advantage of the winds and to keep just within the verge of the storm, the barometer is of signal benefit,—it should be kept as high as possible without losing the wind. In whatever position the ship may be, the rising of the mercury announces that the first (or dangerous) half of the storm has passed.

Hurricane and Storm Seasons.—In tropical regions and on their borders hurricanes occur only at certain seasons of the year; they are periodical; one or more may occur in the season, on rare occasions none. In extra-tropical regions and in high latitudes cyclonic storms have no special period; but may occur in any month.

The West Indian hurricane season is July, August, September, and October.

The Mauritius hurricane season lasts from November to May, both months inclusive.

In the Bay of Bengal cyclones occur at, and are more or less connected with, the change of the monsoons; hence in May and June, and again in October and November.

In the China Sea, and off the south coast of Japan, typhoons are experienced from July to November, both months inclusive.

Among the South Pacific Islands the hurricane season is January, February, and March.

In the tropical part of the South Atlantic hurricanes nknown.

In the Northern part of the North Atlantic and North Pacific, and also in the Southern part of the South Atlantic, South Pacific, and Southern Indian Ocean, these storms may occur at any part of the year.

Tack on which to heave-to.—In the *Northern* hemisphere, in either semicircle of the storm, if the ship is hove-to on the starboard tack, her head is directed from the centre, but if on the port tack towards the centre. In the *Southern* hemisphere, it is when hove-to on the port tack that the ship's head is directed from the centre,—on the starboard tack towards the centre. This is a necessary consequence of the rotation of the wind in the two different hemispheres; and it might seem that the starboard tack would be the proper one for the northern hemisphere, and the port tack for the southern hemisphere, in both semicircles of the storm alike. But there is always the danger of getting sternway when the wind veers by the head; hence, if *obliged to heave-to,* since it is advisable to *put the ship on the tack on which she will come up as the wind shifts,* the *Rule for both hemispheres is :*—

When in the *right-hand* semicircle heave-to on the *starboard* tack.

When in the *left-hand* semicircle heave-to on the *port* tack.

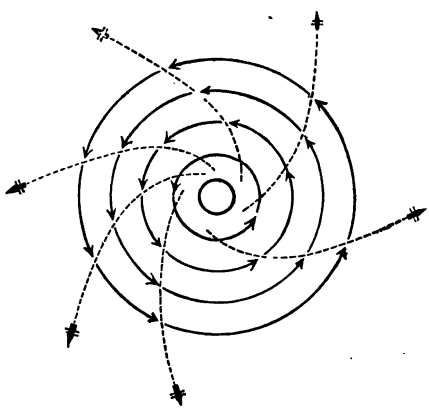
Running before the Wind.—It is recommended, as a rule, not to run before the wind in a hurricane: should it however be necessary, due regard should be had to the *indraught* of the wind; hence *to avoid closing with the centre,* you must if possible—

Keep the *wind* well *on* the *starboard quarter* in the *Northern* hemisphere; but—

Keep the *wind* well *on* the *port quarter* in the *Southern* hemisphere.

In extremely heavy gales there is, of course, danger of broaching-to if the wind be brought on the quarter, so that these instructions can only be followed before the wind becomes too strong.

The following figure is intended to show what would be the track of a ship in the *northern* hemisphere,



when steered so as to keep the wind on the starboard quarter. The reverse of this figure (which may be obtained by holding the leaf up to the light with its back turned to the eye) will show what would be the track of a ship in the *southern* hemisphere, when steered so as to keep the wind on the port quarter. These figures represent the tracks of ships in whirlwinds supposed to be stationary. In gales having progressive movement such tracks would be modified. The best course to be steered so as to carry a ship *away from the centre* of a revolving storm may, after all, depend upon the direction of the swell and sea, as well as of the wind.

The following are Dové Rules, but they are only roximate, and may be referred to, *cautiously*.

I. For Northern Hemisphere. (*Dové.*)

Direction of Wind at commencement of Storm.	Bearing of Centre.	If the Wind shifts from			Steer	Or, otherwise, heave-to, on Port Tack.	But if the Wind shifts from			Heave-to, on Starboard Tack.
N.W.	N.E.	N.W.	towards	W.	S.E.		N.W.	towards	N.	
N.W. by N.	N.E. by E.	N.W. by N.	„	W.	S.E. by S.		N.W. by N.	„	N.	
N.N.W.	E.N.E.	N.N.W.	„	W.	S.S.E.		N.N.W.	„	N.	
N. by W.	E. by N.	N. by W.	„	W.	S. by E.		N. by W.	„	N.	
N.	E.	N.	„	W.	S.		N.	„	E.	
N. by E.	E. by S.	N. by E.	„	N.	S. by W.		N. by E.	„	E.	
N.N.E.	E.S.E.	N.N.E.	„	N.	S.S.W.		N.N.E.	„	E.	
N.E. by N.	S.E. by E.	N.E. by N.	„	N.	S.W. by S.		N.E. by N.	„	E.	
N.E.	S.E.	N.E.	„	N.	S.W.		N.E.	„	E.	
N.E. by E.	S.E. by S.	N.E. by E.	„	N.	S.W. by W.		N.E. by E.	„	E.	
E.N.E.	S.S.E.	E.N.E.	„	N.	W.S.W.		E.N.E.	„	E.	
E. by N.	S. by E.	E. by N.	„	N.	W. by S.		E. by N.	„	E.	
E.	S.	E.	„	N.	W.		E.	„	S.	
E. by S.	S. by W.	E. by S.	„	E.	W. by N.		E. by S.	„	S.	
E.S.E.	S.S.W.	E.S.E.	„	E.	W.N.W.		E.S.E.	„	S.	
S.E. by E.	S.W. by S.	S.E. by E.	„	E.	N.W. by W.		S.E. by E.	„	S.	
S.E.	S.W.	S.E.	„	E.	N.W.		S.E.	„	S.	
S.E. by S.	S.W. by W.	S.E. by S.	„	E.	N.W. by N.		S.E. by S.	„	S.	
S.S.E.	W.S.W.	S.S.E.	„	E.	N.N.W.		S.S.E.	„	S.	
S. by E.	W. by S.	S. by E.	„	E.	N. by W.		S. by E.	„	S.	
S.	W.	S.	„	E.	N.		S.	„	W.	
S. by W.	W. by N.	S. by W.	„	S.	N. by E.		S. by W.	„	W.	
S.S.W.	W.N.W.	S.S.W.	„	S.	N.N.E.		S.S.W.	„	W.	
S.W. by S.	N.W. by W.	S.W. by S.	„	S.	N.E. by N.		S.W. by S.	„	W.	
S.W.	N.W.	S.W.	„	S.	N.E.		S.W.	„	W.	

II. For Southern Hemisphere. (*Dové.*)

Direction of Wind at commencement of Storm.	Bearing of Centre.	If the Wind shifts from		Steer	Or, otherwise, heave-to, on Starboard Tack.	But if the Wind shifts from		Heave-to, on Port Tack.
S.	E.	S.	towards W.	N.		S.	towards E.	
S. by E.	E. by N.	S. by E.	„ S.	N. by W.		S. by E.	„ E.	
S.S.E.	E.N.E.	S.S.E.	„ S.	N.N.W.		S.S.E.	„ E.	
S.E. by S.	N.E. by E.	S.E. by S.	„ S.	N.W. by N.		S.E. by S.	„ E.	
S.E.	N.E.	S.E.	„ S.	N.W.		S.E.	„ E.	
S.E. by E.	N.E. by N.	S.E. by E.	„ S.	N.W. by W.		S.E. by E.	„ E.	
E.S.E.	N.N.E.	E.S.E.	„ S.	W.N.W.		E.S.E.	„ E.	
E. by S.	N. by E.	E. by S.	„ S.	W. by N.		E. by S.	„ E.	
E.	N.	E.	„ S.	W.		E.	„ N.	
E. by N.	N. by W.	E. by N.	„ E.	W. by S.		E. by N.	„ N.	
E.N.E.	N.N.W.	E.N.E.	„ E.	W.S.W.		E.N.E.	„ N.	
N.E. by E.	N.W. by N.	N.E. by E.	„ E.	S.W. by W.		N.E. by E.	„ N.	
N.E.	N.W.	N.E.	„ E.	S.W.		N.E.	„ N.	
N.E. by N.	N.W. by W.	N.E. by N.	„ E.	S.W. by S.		N.E. by N.	„ N.	
N.N.E.	W.N.W.	N.N.E.	„ E.	S.S.W.		N.N.E.	„ N.	
N. by E.	W. by N.	N. by E.	„ E.	S. by W.		N. by E.	„ N.	
N.	W.	N.	„ E.	S.		N.	„ W.	
N. by W.	W. by S.	N. by W.	„ N.	S. by E.		N. by W.	„ W.	
N.N.W.	W.S.W.	N.N.W.	„ N.	S.S.E.		N.N.W.	„ W.	
N.W. by N.	S.W. by W.	N.W. by N.	„ N.	S.E. by S.		N.W. by N.	„ W.	
N.W.	S.W.	N.W.	„ N.	S.E.		N.W.	„ W.	

A BRIEF

DICTIONARY OF SEA TERMS.

ABACK. The situation of the sails when the wind presses their surfaces against the mast, and tends to force the vessel astern.

ABAFT. Towards the stern of a vessel.

ABOARD. Within a vessel.

ABOUT. On the other tack.

A-BOX. Having the head yards aback.

ABREAST. Alongside of. Side by side.

A-COCK-BILL. The situation of the yards when they are topped up at an angle with the deck. The situation of an anchor when it hangs to the cathead by the ring only.

ADRIFT. Broken from moorings or fasts. Without fasts.

AFLOAT. Resting on the surface of the water.

AFORE. Forward. The opposite of abaft.

AFT—AFTER. Near the stern.

AFTER SAILS, and AFTER YARDS. The sails and yards on the main and mizen masts.

AGROUND. Touching the bottom.

AHEAD. In the direction of the vessel's head. *Wind ahead* is from the direction towards which the vessel's head points.

A-HULL. The situation of a vessel when she lies with all her sails furled and her helm lashed a-lee.

A-LEE. The situation of the helm when it is put in the opposite direction from that in which the wind blows.

ALL-ABACK. When all the sails are aback.

ALL HANDS. The whole crew.

ALL IN THE WIND. When all the sails are shaking.

ALOFT. Above the deck.

ALOOF. At a distance.

AMAIN. Suddenly. At once.

AMIDSHIPS. In the centre of the vessel; either with reference to her length or to her breadth.

ANCHOR. The machine by which, when dropped to the bottom, the vessel is held fast.

ANCHOR-WATCH. (See WATCH.)

AN-END. When a mast is perpendicular to the deck.

A-PEEK. When the cable is hove taut so as to bring the vessel nearly over her anchor. The *yards* are *a-peek* when they are topped up by contrary lifts.

APRON. A piece of timber fixed behind the lower part of the stem, just above the fore end of the keel. A kind of false or inner stem, on the after part of the stem, from the head down to the dead-wood, in order to strengthen it. A covering to the vent or lock of a cannon.

ARM. YARD-ARM. The extremity of a yard. Also the lower part of an anchor, crossing the shank and terminating in the flukes.

ARMING. A piece of tallow put in the cavity and over the bottom of a lead-line.

A-STERN. In the direction of the stern. The opposite of a-head.

A-TAUNT. (See TAUNT.)

ATHWART. Across.

Athwart-ships. Across the line of the vessel's keel; across the length of a vessel, in opposition to fore and aft.

Athwart-hawse. Across the direction of a vessel's head. Across her cable.

A-TRIP. The situation of the anchor when it is raised clear of the ground. The same as a-weigh.

AVAST, or 'VAST. An order to stop; as, "Avast heaving!"

A-WEATHER. The situation of the helm when it is put in the direction from which the wind blows.

A-WEIGH. The same as a-trip.

AWNING. A covering of canvas over a vessel's deck, or over a boat, to keep off sun or rain.

BACK. *To back an anchor* is to carry out a smaller one ahead of the one by which the vessel rides, to take off some of the strain.

To back a sail is to throw it aback.

To back and fill is alternately to back and fill the sails.

BACKSTAYS. Long ropes running from a masthead to the vessel's side, slanting a little aft. (See STAYS.)

BAGPIPE. *To bagpipe the mizen* is to lay it aback by bringing the sheet to the weather mizen-rigging.

BALANCE-REEF. A reef in a spanker or fore-and-aft mainsail, which runs from the outer head-earing, diagonally, to the tack. It is the closest reef, and makes the sail triangular, or nearly so.

BALE. *To bale a boat* is to throw water out of her.

BALLAST. Heavy material, as iron, lead, or stone, placed in the bottom of the hold, to keep a vessel from upsetting.

To freshen ballast is to shift it. Coarse gravel is called *shingle ballast.*

BANK. A boat is *double-banked* when two oars, one opposite the other, are pulled by men seated on the same thwart.

BAR. A bank or shoal at the entrance of a harbour.

Capstan-bars are heavy pieces of wood by which the capstan is hove round.

BARE-POLES. The condition of a ship when she has no sail set.

BARGE. A large double-banked boat, used by the commander of a vessel in the navy.

BARK, or BARQUE. A three-masted vessel, having her fore and main masts rigged like a ship's, and her mizen mast like the main mast of a schooner, with no sail upon it but a spanker, and gaff-topsail.

BARNACLE. A shell-fish often found on a vessel's bottom.

BARQUANTINE. A three-masted vessel with yards on her foremast only.

BARREL. The main piece of a capstan, or steering wheel.

BATTENS. Thin strips of wood put around the hatches, to keep the tarpaulin down. Also put upon rigging to keep it from chafing. A large batten widened at the end, and put upon rigging, is called a *Scotchman*.

BEACON. A post or buoy placed over a shoal or bank to warn vessels off. Also as a signal-mark on land.

BEAMS. Strong pieces of timber stretching across the vessel, to support the decks.

On the weather or *lee-beam* is in a direction to windward or leeward, at right angles with the keel.

On beam ends. The situation of a vessel when turned over so that her beams are inclined towards the vertical.

BEAR. An object *bears* so and so, when it is in such a direction from the person looking.

To bear down upon a vessel is to approach her from windward.

To bear up is to put the helm up and keep a vessel off from her course, and move her to leeward.

To bear away is the same as to *bear up;* being applied to the vessel instead of to the tiller.

To bear a-hand. To make haste.

BEARING. The direction of an object from the person looking. The *bearings* of a vessel are the widest part of her below the plank-shear. That part of her hull which is on the water-line when she is at anchor and in her proper trim.

BEATING. Going towards the direction of the wind, by alternate tacks.

BECALM. To intercept the wind. A vessel or highland to windward is said to *becalm* a vessel to leeward. So one sail to windward may *becalm* another to leeward.

BECKET. A piece of rope placed so as to confine a spar or another rope. A handle made of rope, in the form of a circle (as the handle of a chest), is called a *becket*.

BEES. Pieces of plank bolted to the outer end of the bowsprit, to reeve the fore-topmast stays through.

BEFORE THE WIND. Sailing with the wind blowing after the ship.

BELAY. To make a rope fast, by turns round a pin or coil, without hitching or seizing it.

BEND. To make fast.

To bend a sail is to make it fast to the yard.

To bend a cable is to make it fast to the anchor.

A bend is a knot by which one rope is made fast to another.

BENDS. The thickest and strongest planks on the outward part of a vessel's side, to which the beams, knees, and foot-hooks are bolted.

BENEAPED. (See NEAPED.)

BENTINCK SHROUDS. Formerly used, and extending from the futtock-staves to the opposite channels.

BERTH. The place where a vessel lies. The place in which a man sleeps.

BETWEEN-DECKS. The space between any two decks of a ship.

BIBBS. Pieces of timber bolted to the hounds of a mast, to support the trestle-trees.

BIGHT. The double part of a rope when it is folded; in contra-distinction from the ends. Any part of a rope may be called the bight, except the ends. Also a bend in the shore.

BILGE. That part of the floor of a ship upon which she would rest if aground; being near the keel, it is more in a horizontal than a perpendicular line. The largest circumference of a cask.

Bilged. When the bilge is broken in.

Bilge-planks. Thick strengthenings on the inner and outer lines of a ship's bilge.

Bilge-water. Water which settles in the bilge.

Bilge-ways. Pieces of timber bolted together and placed under the bilge in launching.

BILL. The point of the fluke of an anchor. *Bill-boards* protect the ship's planks from the bill of the anchor.

BILLET-HEAD. (See HEAD.)

BINNACLE. A box or stand near the helm, and elsewhere, containing the mariner's compass.

BITTS. Perpendicular pieces of timber going through the deck, placed to secure anything to. The cables are fastened to them, if there is no windlass. There are also *bitts* to secure the windlass, and on each side the heel of the bowsprit.

BITTER, or BITTER-END. The part of the cable abaft the bitts.

BLACKWALL-HITCH. A sort of tackle-hook guy.

BLADE. The flat part of an oar which goes into the water.

BLOCK. A piece of wood, with sheaves or wheels in it, through which the running rigging passes to add to the purchase. (See also TACKLE.)

BLUFF. *A bluff-bowed* or *bluff-headed* vessel is one which is full and square forward.

BOARD. The stretch a vessel makes upon one tack, when she is sailing against the direction of the wind.

Stern-board. When a vessel goes stern foremost.

By the board. Said of masts when they fall over the side.

BOAT-HOOK. An iron hook with a long staff, held in the hand, by which a boat is kept fast to a wharf or vessel.

BOATSWAIN. (Pronounced *bo-s'n.*) A petty officer and chief man of the crew, who has charge of the rigging, calls the crew to duty and superintends their work.

BOBSTAYS. Used to confine the bowsprit down to the stem or cutwater.

BOLSTERS. Pieces of soft wood, covered with canvas, placed on the trestle-trees, for the eyes of the rigging to rest upon.

BOLTS. Long cylindrical bars of iron or copper, used to secure or unite the different parts of a vessel.

BOLT-ROPE. The rope which goes round a sail, and to which the canvas is sewed.

BONNET. An additional piece of canvas attached to the foot of a jib, or a schooner's foresail, by lacings; taken off in bad weather.

BOOM. A spar used to extend the foot of a fore-and-aft sail, or studding-sail.

Boom-irons. Iron rings on the yards, through which the studding-sail booms traverse.

BOOT-TOPPING. Scraping off the grass, or other matter, which may be on a vessel's bottom, and daubing the bottom over with tallow, or some mixture.

BOUND. *Wind-bound.* When a vessel is kept in port by a head-wind.

BOW. The rounded part of a vessel, forward.

BOWER. A working anchor, the cable of which is bent, and reeved through the hawse-hole.

Best-Bower is the larger of the two bowers.

BOW-GRACE. A frame of old rope, or junk, placed round the bows and sides of a vessel, to prevent the ice from injuring her.

BOWLINE. (Pronounced *bo-lin.*) A rope leading forward from the leech of a square sail, to keep the leech well out when sailing close-hauled. A vessel is said to be *on a bowline*, or *on a taut bowline*, when she is close-hauled.

Bowline-bridle. The span on the leech of the sail to which the bowline is toggled. *Bowline-knot* is a particular knot.

Bowline-lizard. A small rope with a thimble in each end; part of the bowline bridle.

BOWSE. To pull upon a tackle.

BOWSPRIT. (Pronounced *bo-sprit.*) A large and strong spar, standing out from the bows of a vessel.

BOX. *To box the compass* is to repeat the thirty-two points of the compass in order.

BOX-HAULING. Wearing a vessel by a series of manœuvres so as to avoid running to leeward as in ordinary wearing.

BRACE. A rope by which a yard is turned about.

To brace a yard is to turn it about horizontally.

To brace up is to lay the yard more fore and aft.

To brace in is to lay it nearer square.

To brace aback. (See ABACK.)

To brace to is to brace the head yards a little aback, in tacking or wearing.

BRAILS. Ropes by which the foot or lower corners of fore-and-aft sails are hauled up.

BRAKE. The handle or lever for working a ship's pump.

BREAK. *To break bulk* is to begin to unload.

To break ground is to lift the anchor from the bottom.

To break shear is when a vessel, at anchor, in tending, is forced the wrong way by the wind or current, so that she does not lie so well for keeping herself clear of her anchor.

BREAKER. A small cask containing water.

BREAMING. Cleaning a ship's bottom by burning.

BREAST-FAST. A rope used to confine a vessel sideways to a wharf, or to some other vessel.

BREAST-HOOKS. Knees placed in the forward part of a vessel, across the stem, to unite the bows on each side.

BREAST-ROPE. A rope passed round a man in the chains, while sounding.

BREECH. The outside angle of a knee-timber. The after end of a gun.

BREECHING. A strong rope used to secure the breech of a gun to the ship's side.

BRIDLE. Spans of rope attached to the leeches of square sails, to which the bowlines are made fast.

Bridle-port. The foremost port, used for stowing the anchors.

BRIG. A square-rigged vessel, with two masts. An *hermaphrodite brig* has a brig's foremast and a schooner's mainmast.

BROACH-TO. To fall off so much, when going free, as to bring the wind round on the other quarter, and take the sails aback.

BROADSIDE. The whole side of a vessel.

BROKEN-BACKED. The state of a vessel when she is so loosened or weakened as to droop at each end.

BUCKLERS. Blocks of wood made to fit in the hawse-holes, or holes in the half-ports, when at sea. Those in the hawse-holes are sometimes called *hawse-blocks*.

BULGE. (See BILGE.)

ILK. The whole cargo, when stowed.

Stowed in bulk is when goods are stowed loose, instead of being stowed in casks or bags. (See *Break-bulk.*)

BULK-HEAD. A partition separating one part of a vessel from another.

BULL. A sailor's term for a small keg, holding a gallon or two.

BULL'S-EYE. A small piece of stout wood, with a hole in the centre for a stay or rope to reeve through, without any sheave, and with a groove round it for the strap, which is usually of iron. Also a piece of thick glass inserted in the deck, to let light below.

BULWARKS. The wood-work round a vessel, above her deck, consisting of boards fastened to stanchions and timber-heads.

BUM-BOATS. Boats which lie alongside a vessel in port with provisions and fruit to sell.

BUMPKINS. Pieces of timber projecting from the vessel to board the fore tack to; and from each quarter for the main brace-blocks.

BUNT. The middle of a sail.

BUNTINE. (Pronounced *buntin.*) Thin woollen stuff of which a ship's colours are made.

BUNTLINES. Ropes used for hauling up the body of a sail.

BUOY. A floating cask, or piece of wood, attached by a rope to an anchor, to show its position. Also floated over a shoal, or other dangerous place, as a beacon.

To stream a buoy is to drop it into the water before letting go the anchor. A buoy is said to *watch* when it floats upon the surface of the water.

BURTON. A tackle, rove in a particular manner.

A single Spanish burton has three single blocks, or two single blocks and a hook in the bight of one of the running parts.

A double Spanish burton has three double blocks.

BUSH. The piece of metal let into the sheave of a block to prevent the sheave from wearing.

BUTT. The end of a plank, where it unites with the end of another.

Scuttle-butt. A cask with a hole cut in its bilge, and kept on deck to hold water for daily use.

BUTTOCK. That part of the convexity of a vessel abaft, under the stern, contained between the counter above and the after part of the bilge below, and between the quarter on the side and the stern-post.

BY. *By the head.* Said of a vessel when her head is lower in the water than her stern. If her stern is lower, she is *by the stern.*

By the wind. Sailing with the yards as near to the wind as possible.

CABIN. The after part of a vessel, in which the officers live.

CABLE. A large, strong rope, or chain made fast to the anchor, by which the vessel is secured. It is usually 120 fathoms in length.

CABLE-TIER. (See TIER.)

CABOOSE. A house on deck, where the cooking is done. Commonly called the *Galley*.

CALK. (See CAULK.)

CAMBERED. When the floor of a vessel is higher at the middle than towards the stem and stern.

CAMEL. A machine used for lifting vessels over a shoal or bar.

CAMFERING, or CHAMFER. Taking off an angle or edge of a timber.

CAN-HOOKS. Slings with flat hooks at each end, used for hoisting barrels or light casks, the hooks being placed round the chimes, and the purchase hooked to the centre of the slings. Small ones are usually wholly of iron.

CANT-PIECES. Pieces of timber fastened to the angles of fishes and side-trees, to supply any part that may prove rotten.

CANT-TIMBERS. Timbers at the two ends of a vessel, raised obliquely from the keel.

Lower Half Cants. Those parts of frames situated forward and abaft the square frames, or the floor-timbers which cross the keel.

CANVAS. The cloth of which sails are made. No. I. is the coarsest and strongest. Ranges from No. I. to No. VI.

CAP. A thick, strong block of wood, with two holes through it, one square and the other round, used to confine together the head of one mast and the lower part of the mast next above it.

CAPSIZE. To overturn.

CAPSTAN. A machine, placed perpendicularly in the deck, and used for a strong purchase in heaving or hoisting. (See BAR.)

CAREEN. To heave a vessel down upon her side by purchases upon the masts. To lie over, when sailing on the wind.

CARLINGS. Short and small pieces of timber running between the beams.

CARRICK-BEND. A kind of knot.

Carrick-bitts are the windlass bitts.

CARRY AWAY. To break a spar, or part a rope.

CAST. To pay a vessel's head off, in getting under weigh, on the tack she is to sail upon.

CAT. The tackle used to hoist the anchor up to the cat-head.

Cat-block. The block of this tackle.

CAT-HARPIN. An iron leg used to confine the upper part of the rigging to the mast.

CAT-HEAD. Large timbers projecting from the vessel's side, to which the anchor is raised and secured.

CAT'S-PAW. A kind of hitch made in a rope. A light current of air seen on the surface of the water during a calm.

CAULK. To fill the seams of a vessel with oakum.

CLEAT. (See KEVEL.)

CLOSE. The inside planking (lining) of a vessel.

CHAFE. To rub the surface of a rope or spar.

Chafing-gear is the stuff put upon the rigging and spars to prevent their chafing.

CHAINS. Strong links or plates of iron, the lower ends of which are bolted through the ship's side to the timbers. The upper ends are secured to the bottom of the dead-eyes in the channels. Also used familiarly for the CHANNELS, which see. The *chain-cable* of a vessel is called familiarly her *chain*.

Rudder-chains lead from the outer and upper end of the rudder to the quarters. They are hung slack.

CHAIN-PLATES. Plates of iron bolted to the side of a ship, to which the chains and dead-eyes of the lower rigging are connected.

CHANNELS. Broad pieces of plank bolted edgewise to the outside of a vessel. Used for spreading the lower rigging. (See CHAINS.)

CHAPELLING. Wearing a ship round, when taken aback in a light breeze, without bracing the head-yards.

CHECK. A term sometimes used for slacking off a little on a brace, and then belaying it.

CHEEKS. The projections on each side of a mast, upon which the trestle-trees rest. The sides of the shell of a block.

CHEERLY! Quickly, with a will.

CHESS-TREES. Pieces of oak, fitted to the sides of a vessel, abaft the fore chains with a sheave in them, to board the main tack to. Now out of use.

CHIMES. The ends of the staves of a cask, where they come out beyond the head of the cask.

CHINSE. To thrust oakum into seams with a small iron.

CHOCK. A wedge used to secure anything with, or for anything to rest upon. The long boat rests upon two large *Chocks*, when it is stowed.

Chock-a-block. When the lower block of a tackle is run close up to the upper one, so that you can hoist no higher. This is also called *two-blocks* or *block and block.*

CISTERN. An apartment in the hole of a vessel, having a pipe leading out through the side, with a cock, by which water may be let into her.

CLAMPS. Thick planks on the inside of vessels, to support the ends of beams. Also crooked plates of iron fore-locked upon the trunnions of cannon. Any plate of iron made to turn, open, and shut, so as to confine a spar or boom, as—a studdingsail boom, or a boat's mast.

CLASP-HOOK. (See CLOVE-HOOK.)

CLEAT. A piece of wood used in different parts of a vessel to belay ropes to.

CLEW. The lower corner of square sails, and the after corner of a fore-and-aft sail.

To clew up is to haul up the clew of a sail.

CLEW-GARNET. A rope that hauls up the clew of a foresail or mainsail in a square-rigged vessel.

CLEWLINE. A rope that hauls up the clew of a square-sail. The *clew-garnet* is the clewline of a course.

CLINCH. A half-hitch, stopped to its own part.

CLOSE-HAULED. Applied to a vessel which is sailing with her yards braced up so as to get as much as possible to windward. The same as *on a taut bowline, full and by, on the wind*, &c.

CLOVE-HITCH. Two half-hitches round a spar or other rope.

CLOVE-HOOK. An iron clasp, in two parts, moving upon the same pivot, and overlapping one another. Used for bending chain-sheets to the clews of sails.

CLUB-HAUL. To bring a vessel's head round on the other tack, by letting go the lee anchor, and cutting or slipping the cable.

CLUBBING. Drifting down a current with an anchor out.

COAKING. Uniting pieces of spar by means of tubular projections formed by cutting away the solid of one piece into a hollow, so as to make a projection on the other, in such a manner that they may correctly fit, the butts preventing the pieces from drawing asunder.

Coaks are fitted into the beams and knees of vessels to prevent their drawing.

COAL TAR. Tar made from bituminous coal.

COAMINGS. Raised work round the hatches, to prevent water going down the hold.

COAT. *Mast-coat* is a piece of canvas, tarred or painted, placed round a mast or bowsprit where it enters the deck.

COCK-BILL. To cock-bill a yard or anchor. (See A-COCK-BILL.)

COCK-PIT. An apartment in a vessel of war, used by the surgeon during an action.

CODLINE. An eighteen-thread line.

COXSWAIN. (Pronounced *cox'n.*) The person who steers a boat and has charge of her.

COIL. To lay a rope up in a ring, with one turn or fake over another. *A coil* is a quantity of rope laid up in that manner.

COLLAR. An eye in the end or bight of a shroud or stay, to go over the mast-head.

COME. *Come home*, said of an anchor when it is broken from the ground and drags.

To come up a rope or tackle is to slack it off.

COMPANION. A wooden covering over the staircase to a cabin.

Companion-way. The staircase to the cabin.

Companion-ladder. The ladder leading from the poop to the main deck.

COMPASS. The instrument which tells the course of a vessel.

Compass-timbers are such as are curved or arched.

CONCLUDING-LINE. A small line leading through the centre of the steps of a rope or Jacob's ladder.

CONNING, or CUNNING. Directing the helmsman in steering a vessel.

COUNTER. That part of a vessel between the bottom of the stern and the wing-transom and buttock.

Counter-timbers are short timbers put in to strengthen the counter.

To counter-brace yards is to brace the head-yards one way and the after-yards another.

COURSE. The direction in which the helmsman is ordered to keep the ship's head by compass.

COURSES. The sails that hang from a ship's lower yards. The foresail is the *fore course*, and the mainsail the *main course*.

COVERING BOARD. (See PLANK-SHEERS.)

CRANES. Pieces of iron or timber at the vessel's sides, used to stow boats or spars upon. A machine used at a wharf for hoisting.

CRANK. The condition of a vessel when she is inclined to lean over a great deal and cannot bear much sail. This may be owing to her construction or to her stowage.

CREEPER. An iron instrument, like a grapnel, with four claws, used for dragging the bottom of a harbour or river, to find anything lost.

CRINGLE. A short piece of rope with each end spliced into the bolt-rope of a sail, confining an iron ring or thimble.

CROSS-BARS. Round bars of iron, bent at each end, used as levers to turn the shank of an anchor.

CROSS-CHOCKS. Pieces of timber fayed across the dead-wood amidships, to make good the deficiency of the heels of the lower futtocks.

CROSS-JACK. (Pronounced *croj-jack*.) The cross-jack yard is the lower yard on the mizen mast.

CROSS-PAWLS. Pieces of timber that keep a vessel together while in her frames.

CROSS-PIECE. A piece of timber connecting two bitts.

CROSS-SPALES. Pieces of timber placed across a vessel, and nailed to the frames, to keep the sides together until the knees are bolted.

CROSS-TREES. Pieces of oak supported by the cheeks and trestle-trees, at the mast heads, to sustain the tops on the lower mast, and to spread the topgallant rigging at the topmast head.

CROW-FOOT. A number of small lines rove through an euvrow or long block to suspend an awning by.

CROWN of an anchor, is the place where the arms are joined to the shank.

To crown a knot is to pass the strands over and under each other above the knot.

CRUTCH. A knee, or piece of knee timber, placed inside of a vessel to secure the heels of the cant-timbers abaft. Also the chock upon which the spanker boom rests when the sail is not set.

CUCKOLD'S NECK. A knot by which a rope is secured to a spar—the two parts of the rope crossing each other and seized together.

CUDDY. A cabin in the fore part of a boat. In large vessels a cabin abaft.

CUTLINE, or CUNTLINE. The space between the bilges of two casks, stowed side by side. Where one cask is set upon the cuntline between two others, they are stowed *bilge and cuntline.*

CUT-WATER. The foremost part of a vessel's prow, which projects forward of the bows.

CUTTER. A small boat. Also a kind of sloop.

DAGGER. A piece of timber crossing all the poppets of the bilge-ways to keep them together.

Dagger-knees. Knees placed obliquely, to avoid a port.

DAVITS. Pieces of timber or iron, with sheaves or blocks at their ends, projecting over a vessel's sides or stern, to hoist boats up to. Also a spar with a roller or sheave at its end, used for fishing the anchor, called a *fish-davit.*

DEAD-EYE. A circular block of wood, with three holes through it, for the lanyards of rigging to reeve through, without sheaves, and with a groove round it for an iron strap.

DEAD-FLAT. The midship bend, at the broadest part of the ship.

DEAD-LIGHTS. Ports placed in the cabin windows in bad weather.

DEAD RECKONING. A reckoning kept by observing a vessel's courses and distances by the log, to ascertain her position.

DEAD-RISING, or RISING-LINE. Those parts of a vessel's floor, throughout her whole length, where the floor timber is terminated upon the lower futtock.

DEAD-WATER. The eddy under a vessel's counter.

DEAD-WOOD. Blocks of timber, laid upon each end of the keel (near stem and stern-post) where the vessel narrows.

DECK. The planked floor of a vessel, resting upon her beams.

DECK-STOPPER. A stopper used for securing the cable forward of the windlass or capstan, while it is overhauled. (See STOPPER.)

DEEP-SEA-LEAD. (Pronounced *dipsey.*) The lead used in sounding at great depths.

DEPARTURE. The easting or westing made by a vessel. The bearing of an object on the coast from which a vessel commences her dead reckoning.

DERRICK. A single spar supported by stays and guys, to which a purchase is attached, used to unload vessels, and for hoisting.

DOG. A short iron bar, with a fang or teeth at one end, and a ring at the other. Used for a purchase, the fang being placed against a beam or knee, and the block of a tackle hooked to the ring.

DOG-VANE. A small vane, made of feathers, or buntine, to show the direction of the wind.

DOG-WATCHES. Half watches of two hours each, from 4 to 6 and from 6 to 8 P.M. (See WATCH.)

DOLPHIN. A rope, or strap round a mast, to support the puddening, where the lower yards rest in the slings. Also a spar or buoy with a large ring in it, secured to an anchor, to which vessels may bend their cables.

DOLPHIN-STRIKER. The martingale.

DOUSE. To lower suddenly.

DOWELLING. A method of coaking, by letting pieces into the solid, or uniting two pieces together by tenons.

DOWNHAUL. A rope used to haul down jibs, staysails, and studding sails.

DRABLER. A piece of canvas laced to the bonnet of a sail, to give it more drop.

DRAG. A machine with a bag net, used for dragging on the bottom for anything lost.

DRAUGHT. The depth of water which a vessel requires to float her.

DRAW. A sail *draws* when it is filled by the wind.

To draw a jib is to shift it over the stay to leeward, when it is aback.

DRIFTS. Those pieces in the sheer-draught where the rails are cut off.

DRIVE. To scud before a gale, or to drift in a current.

DRIVER. A spanker.

DROP. The depth of a sail, from head to foot, amidships.

DRUM-HEAD. The top of the capstan.

DUBB. To reduce and smooth with an adze the end of a timber.

DUCK. A kind of cloth, lighter and finer than canvas; used for small sails.

DUNNAGE. Loose wood, or other matters, placed on the bottom of the hold, above the ballast, to stow cargo upon.

EARING. A rope attached to the cringle of a sail, by which it is bent or reefed.

EASE-OFF. To slacken out a rope or tackle-fall carefully.

EIKING. A piece of wood fitted to make good a deficiency in length.

ELBOW. Two crosses in a hawse.

ESCUTCHEON. The part of a vessel's stern where her name is written.

EVEN-KEEL. The situation of a vessel when she is so trimmed that she sits evenly upon the water, neither end being down more than the other.

EUVROW, or EUPHROE. A piece of wood, by which the legs of the crow-foot to an awning are extended.

EYE. The circular part of shroud or stay, where it goes over a mast.

Eye-bolt. A long iron bar, having an eye at one end, driven through a vessel's deck or side into a timber or beam, with the eye remaining out, to hook a tackle to. If here is a ring through this eye, it is called a *ring-bolt.*

An Eye-splice is a certain kind of splice made with the end of a rope.

Eyelet-hole. A hole made in a sail for a cringle or roband to go through.

The Eyes of a vessel. A familiar phrase for the forward part.

FACE-PIECES. Pieces of wood wrought on the fore part of the knee of the head.

FACING. Letting one piece of timber into another, with a rabbet.

FAG. A rope is *fagged* when the end is untwisted.

FAIR-LEADER. A strip of board or plank, with holes in it, for running rigging, to lead through. Also a block or thimble used for the same purpose.

FAKE. One of the circles or rings made in coiling a rope.

FALL. That part of a tackle to which the power is applied in hoisting.

FALLING OFF. The vessel's head turning more to leeward.

FALSE KEEL. Pieces of timber secured under the main keel of vessels.

FANCY-LINE. A line rove through a block at the jaws of a gaff, used as a downhaul. Also a line used for cross-hauling the lee topping lift.

FASHION PIECES. The aftermost timbers, terminating the breadth and forming the shape of the stern.

FAST. A rope by which a vessel is secured to a wharf. There are *bow* or *head*, *breast*, *quarter*, and *stern* fasts.

FATHOM. Six feet.

FAY. To fit any two pieces of wood so as to join close and fair together.

FEATHER. *To feather an oar* in rowing is to turn the blade horizontally with the top aft as it comes out of the water.

FEATHER-EDGED. Planks which have one side thicker than another.

FENDERS. Pieces of rope or wood hung over the side of a vessel or boat, to protect it from chafing. The fenders of a neat boat are usually made of canvas, and stuffed.

FID. A square block of wood or iron, placed through the hole in the heel of the mast, and resting on the trestle-trees of the mast below; this supports the mast. Also a conical wooden pin, tapered, used in splicing large ropes, in opening eyes, &c.

FIDDLE-BLOCK. A long shell, having one sheave over the other, and the lower smaller than the upper.

FIDDLE-HEAD. (See HEAD.)

FIFE-RAIL. The rail going round a mast.

FIGURE-HEAD. A carved head or full-length figure, over the cutwater.

FILLINGS. Pieces of timber used to make the curve fair for the mouldings, between the edges of the fish-front and the sides of the mast.

FILLER. A filling piece in a made mast.

FINISHING. Carved ornaments of the quarter-galley, below the second counter, and above the upper lights.

FISH. To raise the flukes of an anchor upon the gunwale. Also to strengthen a spar when sprung or weakened, by putting in or fastening on another piece.

Fish-front. The strengthening slab on a made mast.

FISH-DAVIT. The davit used for fishing an anchor.

FISH-HOOK. A hook with a pennant, to the end of which the fish-tackle is hooked.

FISH-TACKLE. The tackle used for fishing an anchor.

FLARE. When the vessel's sides go out from the perpendicular. In opposition to *falling home* or *tumbling-in*.

FLAT. A sheet is said to be hauled *flat* when it is hauled down close.

Flat-aback, when a sail is blown with its after surface against the mast.

FLATTEN IN. Hauling the head sheets as much to windward as possible to increase the pressure of wind against the sails.

FLEET. To come up a tackle and draw the blocks apart, for another pull, after they have been hauled *two-blocks*.

Fleet-ho! The order given at such times. Also to shift the position of a block or fall, so as to haul to more advantage.

FLEMISH COIL. (See FRENCH-FAKE.)

FLEMISH-EYE. A kind of eye-splice.

FLEMISH-HORSE. An additional foot-rope at the ends of topsail yards.

FLOOR. The bottom of a vessel, on each side of the keelson.

FLOOR TIMBERS. Those timbers of a vessel which are placed across the keel.

FLOTSAM. Anything found floating on the water, as cargo, wreck, &c.

FLOWING SHEET. When a vessel has the wind free, and the lee clews eased off.

FLUKES. The broad triangular plates at the extremity of the arms of an anchor, terminating in a point called the *bill*.

FLY. That part of a flag which extends from the union or staff to the extreme end. (See UNION.) Also the compass card.

FOOT. The lower end of a mast or sail. (See FORE-FOOT.)

Foot of sail. The lower edge of a square sail from clew to clew, but of a fore-and-aft sail from tack to clew.

FOOT-ROPE. The rope stretching along a yard, upon which men stand when reefing or furling; formerly called *horses*.

FOOT-WALING. The inside planks or lining of a vessel, over the floor-timbers.

FORE. Used to distinguish the forward part of a vessel, or things in that direction—as, *fore mast*, *fore hatch*; in opposition to *aft* or *after*.

FORE-AND-AFT. Lengthwise with the vessel. In opposition to *athwart ships*. (See SAILS.)

FORECASTLE. That part of the upper deck forward of the foremast

or, as some say, forward of the after part of the fore channels. Also the forward part of the vessel, under the deck, where the sailors live, in merchant vessels.

FORE-FOOT. A piece of timber at the forward extremity of the keel upon which the lower end of the stem rests.

FORE-GANGER. A short piece of rope grafted on a harpoon, to which the line is bent.

FORE-LOCK. A flat piece of iron, driven through the end of a bolt, to prevent its drawing.

FORE MAST. The forward mast of all vessels.

FORE-REACH. To shoot ahead, especially when going in stays.

FORE-RUNNER. A piece of rag, terminating the stray-line of the log-line.

FORGE. *To forge ahead*, to shoot ahead; as, in coming to anchor, after the sails are furled. (See FORE-REACH.)

FORMERS. Pieces of wood used for shaping cartridges or wads.

FOTHER, or FODDER. To draw a sail filled with oakum, under a vessel's bottom, in order to stop a leak.

FOUL. The term for the opposite of clear.

FOUL ANCHOR. When the cable has a turn round the anchor.

FOUL HAWSE. When the two cables are crossed or twisted outside the stem.

FOUNDER. A vessel *founders* when she fills with water and sinks.

FOX. Made by twisting together two or more rope-yarns.

A Spanish fox is made by untwisting a single yarn and laying it up the contrary way.

FRAP. To pass ropes round a sail to keep it from blowing loose. Also to draw ropes round a vessel which is weakened, to keep her together.

FREE. A vessel is going *free* when she has a fair wind and her yards braced in. A vessel is said to be *free* when the water has been pumped out of her.

FREE-BOARD. The distance from the underneath part of the main deck to the water's edge.

FRESHEN. To relieve a rope, by moving its place; as, to *freshen the nip* of a stay is to shift it, so as to prevent its chafing through.

To freshen ballast is to alter its position.

FRENCH-FAKE. To coil a rope with each fake outside of the other, beginning in the middle. If there are to be riding fakes, they begin outside and go in; and so on. This is called a *Flemish coil.*

FULL-AND-BY. Sailing close-hauled on a wind.

Full-and-by! The order given to the man at the helm to keep the sails full and at the same time close to the wind.

Keep her full, i.e. keep the sail full of wind; not shaking.

FURL. To roll a sail up snugly on a yard or boom, and secure it.

GUTTOCK-PLATES. Iron plates crossing the sides of the top-rim per-

pendicularly. The dead eyes of the topmast rigging are fitted to their upper ends, and the futtock-shrouds to their lower ends.

FUTTOCK-SHROUDS. Short shrouds, leading from the lower ends of the futtock-plates to a bend round the lower mast, just below the top.

FUTTOCK-STAFF. A short piece of wood or iron, seized across the upper part of the rigging, to which the catharpin legs are secured.

FUTTOCK-TIMBERS. Those timbers between the floor and naval timbers, and the top timbers. There are two—the *lower*, which is over the floor, and the *middle*, which is over the naval timber. The naval timber is sometimes called the *ground futtock*.

GAFF. A spar to which the head of a fore-and-aft sail is bent.

GAFF-TOPSAIL. A light sail set over a gaff, the foot being spread by it.

GAGE. The depth of water of a vessel. Also her position as to another vessel, as having the *weather* or *lee gage*.

GALLEY. The place where the cooking is done.

GALLOWS-BITTS. A strong frame raised amidships, to support spare spars, &c., in port.

GAMMONING. The lashing by which the bowsprit is secured to the cut-water.

GANG. Term used for quantity, as a gang (or set) of rigging.

GANG-CASKS. Small casks, used for bringing water on board in boats.

GANGWAY. That part of a vessel's side, amidships, where people pass in and out of a vessel.

GANTLINE. (See GIRTLINE.)

GARBOARD-STRAKE. The first line of planking next the keel, on each side.

GARLAND. A large rope, strap or grommet, lashed to a spar when hoisting it inboard.

GARNET. A purchase on the mainstay, for hoisting cargo.

GASKETS. Ropes or pieces of plaited stuff, used to secure a sail to the yard or boom when it is furled. They are called a *bunt*, *quarter*, or *yard-arm gasket*, according to their position on the yard.

GIMBLET. To turn an anchor round by its stock. To turn anything round on its end.

GIRT. The situation of a vessel when her cables are too taut.

GIRTLINE. A rope rove through a single block aloft, making a whip purchase. Commonly used to hoist rigging by, in fitting it.

GIVE WAY! An order to men in a boat to pull with more force, or to begin pulling. The same as, *Lay out on your oars!* or *Lay out!*

GLUT. A piece of canvas sewed into the centre of a sail, near the head. It has an eyelet hole in the middle for the bunt-jigger or becket to go through.

GOB-LINE, or GAUB-LINE. A rope leading from the martingale inboard. The same as *back-rope*.

GOOSE-NECK. An iron ring fitted to the end of a yard or boom, for various purposes.

GOOSE-WINGED. The situation of a course when the buntlines and lee-clew are hauled up, and the weather-clew down.

GORES. The angles at one or both ends of such cloths as increase the breadth or depth of a sail.

GORING-CLOTHS. Pieces cut obliquely and put in to add to the breadth of a sail.

GRAFTING. A manner of covering a rope by weaving together yarns.

GRAPNEL. A small anchor, with several claws, used to secure boats.

GRATING. Open lattice work of wood. Used principally to cover hatches in good weather.

GREAVE. To clean a ship's bottom by burning.

GRIPE. The scarph at the end of the stem and keel, and of the stern-post and keel. A piece of timber fitted on the lower part of the stem; it helps to keep the vessel's head to windward by resisting the lee drift.

GRIPES. Bars of iron, with lanyards, rings, and clews, by which a large boat is lashed to the ring-bolts of the deck. Those for a quarter-boat are made of long strips of matting, going round her and set taut by a lanyard.

A vessel *gripes* when she tends to come up into the wind.

GROMMET. A ring formed of rope, by laying round a single strand.

GROUND-TACKLE. General term for anchors, cables, warps, springs, &c.; everything used in securing a vessel at anchor.

GROUND-TIER. The lowest tier of casks in a vessel's hold.

GUDGEONS. Metal braces with eyes bolted on the stern post for the pintles of the rudder to work in.

GUESS-WARP. A rope taken by a boat to a buoy, &c., made fast, and the other end brought to the ship.

GUEST-ROPE. A rope fastened to a vessel or wharf, for a boat's use; or to haul it out to the swinging boom-end, when in port.

GUNTACKLE PURCHASE. A purchase made by two single blocks.

GUNWALE. (Pronounced *gun-nel.*) The horizontal plank covering the heads of timbers between the main and fore drifts. The upper rail of a boat.

GUY. A rope attaching to anything to steady it, and bear it one way and another in hoisting.

GYBE. (Or, *jibe.*) To shift over the boom of a fore-and-aft sail.

HAIL. To speak or call to another vessel, or to men.

HALYARDS. Ropes or tackles used for hoisting and lowering yards, gaffs, and sails.

HALF-HITCH. A kind of knot.

HAMMOCK. A swinging sea-bed made of canvas, and hung at each end.

HAND. To *hand* a sail is to *furl* it.

Bear-a-hand: make haste. *Lend-a-hand:* assist.

Hand-over-hand: hauling rapidly on a rope, by putting one hand before the other alternately.

HAND-LEAD. A small lead, used for sounding in rivers and harbours.

HANDSOMELY. Slowly, carefully. Used for an order, as, "Lower handsomely!"

HANDSPIKE. A long wooden bar, used for heaving at the windlass.

HANDY BILLY. A watch-tackle.

HANKS. Rings or hoops of wood, rope, or iron, round a stay, and seized to the luff of a fore-and-aft sail.

HARD DOWN. The order to put the tiller hard over to leeward. *Hard up*, to put it hard over to windward.

HARPINGS. The fore part of the wales, which encompass the bows of a vessel, and are fastened to the stem.

HATCH, or HATCHWAY. An opening in the deck to afford a passage up and down. The coverings over these openings are also called *hatches*.

Hatch-bar is an iron bar going across the hatches to keep them down.

HAUL. *Haul her wind*, said of a vessel when she comes up close upon the wind.

HAWSE. The situation of the cables before the vessel's stem when moored. Also the distance upon the water a little in advance of the stem: as, a vessel sails *athwart the hawse*, or anchors *in the hawse* of another.

Open hawse. When a vessel rides by two anchors, without any cross in her cables.

HAWSE-BOX. Woodwork outside a ship to support the hawse-pipe.

HAWSE-HOLE. The hole in the bows through which the cable runs.

HAWSE-PIECES. Timbers through which the hawse-holes are cut.

HAWSE-BLOCK. A block of wood fitted into a hawse-hole at sea.

HAWSER. A large rope used for various purposes, as warping, for a spring, &c.

HAWSER-LAID, or CABLE-LAID rope, is rope laid with nine strands against the sun.

HAZE. A term for punishing a man by keeping him unnecessarily at work upon disagreeable or difficult duty.

HEAD. The work at the prow of a vessel; if it is a carved figure, it is called a *figure-head;* if simple carved work, bending over and out, a *billet-head;* and if bending in, like the head of a violin, a *fiddle-head.* Also the upper end of a mast, called a *mast-head.* The *head of a sail* is the upper edge of a square sail, which is bent to the yard, but the upper corner of a triangular sail. (See BY-THE-HEAD. See FAST.)

HEAD-LEDGES. Thwartship pieces that frame the hatchways.

HEAD-SAILS. A general name given to all sails set forward of the foremast.

HEAD-WAY. Going a-head.

HEAD YARDS. The yards attached to the foremast.

HEART. A block of wood in the shape of a heart, for stays to reeve through.

HEART-YARNS. The centre yarns of a strand.

HEAVE SHORT. To heave in on the cable until the vessel is nearly over her anchor.

HEAVE-TO. To put a vessel in the position of lying-to. (See LIE-TO.)

HEAVE IN STAYS. To go about in tacking.

HEAVER. A short wooden bar, tapering at each end; used as a purchase.

HEEL. The after part of the keel. Also the lower end of a mast or boom. Also the lower end of the stern post.

To heel is to lie over on one side.

Going round on her heel. Wearing ship without making any headway.

HEELING. The square part of the lower end of a mast, through which the fid-hole is made.

HELM. The machinery by which a vessel is steered, including the rudder, tiller, wheel, &c. Properly the tiller.

HELM-PORT. The hole in the counter through which the rudder-head passes.

HELM-PORT TRANSOM. A piece of timber placed across the lower counter, inside at the height of the helm-port, and bolted through every timber, for the security of that port.

HIGH AND DRY. The situation of a vessel when she is aground above water mark.

HITCH. A peculiar manner of fastening ropes. A kind of knot.

HOG. A flat, rough broom, used for scrubbing the bottom of a vessel.

HOGGED. The state of a vessel when by any strain she droops at each end, bringing her centre up, causing an upward arching in the keel.

HOLD. The interior of a vessel where the cargo is stowed.

HOLD-WATER. To stop the progress of a boat by keeping the oar-blades in the water.

HOLY-STONE. A large stone, used for cleaning a ship's decks.

HOME. The sheets of a sail are said to be *home*, when the clews are hauled chock out to the sheave-holes. An anchor *comes home* when it is loosened from the ground, and is hove in towards the vessel.

HOOD. A covering for a companion hatch, skylight, &c.

HOOD-ENDS, or HOODING-ENDS, or WHOODEN-ENDS. The ends of the planks which fit into the rabbets in the stem or sternpost.

HOOK-AND-BUTT. The scarphing, or laying the ends of timbers over each other.

HORNS. The jaws of booms. Also the ends of cross-trees.

HORSE. (See FOOT-ROPE.)

HOUNDS. Those projections at the mast-head serving as shoulders for the top or trestle-trees to rest upon.

HOUSE. To *house* a mast is to lower it about half its length, and secure it by lashing its heel to the mast below.

To house a gun is to run it in clear of the port and secure it.

HOUSING, or HOUSE-LINE. (Pronounced *houze-lin.*) A small cord made of three small yarns, and used for seizings.

HULL. The body of a vessel. (See A-HULL.)

IN-AND-OUT. A term sometimes used for the scantline of the timbers, the moulding way, and particularly for those bolts that are driven into the hanging and lodging knees, through the sides, which are called *in-and-out bolts.*

INNER-POST. A piece brought on at the fore side of the main-post and generally continued as high as the wing-transom, to seat the other transoms upon.

IRONS. A ship is said to be in *irons* when, in working, she will not cast one way or the other.

JACK. A common term for the *jack-cross-trees.* (See also UNION.)

JACK-BLOCK. A block used in sending topgallant masts up and down.

JACK-CROSS-TREE. Iron cross-trees at the head of long topgallant masts.

JACK-STAFF. A short staff, raised at the bowsprit cap, upon which the Union Jack is hoisted.

JACK-STAYS. Ropes stretched taut along a yard to bend the head of the sail to. Also long strips of wood or iron, used now for the same purpose.

JACK-SCREW. A purchase, used for stowing cotton.

JACOB'S-LADDER. A ladder made of rope, with wooden steps.

JAWS. The inner ends of booms or gaffs, hollowed in.

JEERS. Tackles for hoisting the lower yards.

JETSAM. Goods thrown overboard, or found upon the shore.

JETTISON. The act of throwing cargo overboard.

JEWEL-BLOCKS. Single blocks at the yard-arms, through which the studdingsail halyards lead.

JIB. A triangular sail, set on a stay, forward.

Flying jib sets outside of the jib, and the *jib-o'-jib* outside of that.

JIB-BOOM. The boom rigged out beyond the bowsprit, to which the tack of the jib is lashed.

JIGGER. A small tackle used about decks or aloft.

JOLLY-BOAT. A small boat, usually hoisted at the stern.

JUNK. Condemned rope, cut up and used for making mats, swabs, oakum, &c.

JURY-MAST. A temporary mast, rigged at sea, in place of one lost.

KECKLING. Old rope wound round cables, to keep them from chafing. (See ROUNDING.)

KEDGE. A small anchor, with an iron stock, used for warping.

To kedge is to warp a vessel ahead by a kedge and hawser.

KEEL. The lowest and principal timber of a vessel, running fore-and-aft its whole length, and supporting the whole frame. It is composed of several pieces, placed lengthwise, and scarphed and bolted together. (See FALSE KEEL.)

KEEL-HAUL. To haul a man under a vessel's bottom, by ropes at the yard-arms on each side.

KEELSON. A timber placed over the keel on the floor-timbers, and running parallel with it.

KEEPING AWAY. Steering more away from the wind.

KENTLEDGE. Pig-iron ballast, laid each side of the keelson.

KEVEL, or CAVIL. A strong piece of wood, bolted to some timber or stanchion, used for belaying large ropes to.

KEVEL-HEADS. Timber-heads used as kevels.

KINK. A twist in a rope.

KNEES. Crooked pieces of timber, having two arms, used to connect the beams of a vessel with her timbers. (See DAGGER.)

Lodging knees are placed horizontally, having one arm bolted to a beam, and the other across two of the timbers.

Knee of the head is placed forward of the stem, and supports the figure-head.

KNIGHT-HEADS, or BOLLARD-TIMBERS. The timbers next the stem on each side, and continued high enough to form a support for the bowsprit.

KNITTLES, or NETTLES. The halves of two adjoining yarns in a rope twisted up together, for pointing or grafting. Also small line used for seizings and for hammock clews.

KNOCK-OFF! An order to leave off work.

KNOT. A division on the log-line, answering to a mile of distance.

LABOUR. A vessel is said to *labour* when she rolls or pitches heavily.

LACING. Rope used to lash a sail to a gaff, or a bonnet to a sail. Also a piece of compass or knee timber, fayed to the back of the figure-head and the knee of the head, and bolted to each.

LAGAN. Articles sunk in the water with a buoy attached.

LAND-FALL. The making land after being at sea.

A good land-fall is when a vessel makes the land as intended.

LAND HO! The cry used when land is first seen.

LANYARDS. Ropes rove through dead-eyes for setting up rigging. Also a rope made fast to anything to secure it, or as a handle, is called a *lanyard*.

LARBOARD. The left side of a vessel looking forward (now obsolete).

LARBOWLINES. The familiar term for the men in the larboard watch.

LARGE. A vessel is said to be going *large* when she has the wind free.

LATCHINGS. Loops on the head-rope of a bonnet, by which it is laced to the foot of the sail.

LAUNCH. A large boat. The LONG-BOAT.

LAUNCH HO! High enough!

LAY. To come or to go; as, *Lay aloft! Lay forward! Lay aft!* Also the direction in which the strands of a rope are twisted; as, from left to right, or from right to left.

LEACH. (See LEECH.)

LEACHLINE. A rope used for hauling up the leach of a sail.

LEAD. A piece of lead, in the shape of a cone or pyramid, with a small hole at the base, and a line attached to the upper end, used for sounding. (See HAND-LEAD, DEEP-SEA-LEAD.)

LEADING-WIND. A fair wind. More particularly applied to a wind abeam or quartering.

LEAK. A hole or breech in a vessel at which the water comes in.

LEDGES. Small pieces of timber placed athwart ships under the decks of a vessel, between the beams.

LEE. The side opposite to that from which the wind blows; as, if a vessel has the wind on her starboard side, that will be the *weather*, and the port will be the *lee*, side.

A lee shore is the shore upon which the wind is blowing.

Under the lee of anything is when you have that between you and the wind.

By the lee. The situation of a vessel going free, when she has fallen off so much as to bring the wind round her stern, and to take her sails aback on the other side.

LEE-BOARD. A board fitted to the lee side of flat-bottomed boats, to prevent their drifting to leeward.

LEE-GAGE. (See GAGE.)

LEE-WAY. What a vessel loses by drifting to leeward. When sailing close-hauled with all sail set, a vessel should make no leeway. If the topgallant sails are furled, it is customary to allow one point; under close-reefed topsails, two points; when under one close-reefed sail, four or five points.

LEECH, or LEACH. The border or edge of a sail, at the sides.

LEEFANGE. An iron bar, upon which the sheets of fore-and-aft sails traverse. Also a rope rove through the cringle of a sail which has a bonnet to it, for hauling in, so as to lace on the bonnet. Not much used.

LEE HELM. Tiller down to leeward.

LEEWARD. (Pronounced *lu-ard.*) The lee side. In a direction opposite to that from which the wind blows, which is called *windward*. The opposite of *lee* is *weather*, and of *leeward* is *windward*.

LIE-TO is to stop the progress of a vessel at sea either by counterbracing the yards, or by reducing sail, so that she will make little or no headway, but will merely come to and fall off by the counteraction of the sails and helm.

LIFE-LINES. Ropes carried along yards, booms, &c., or at any part of the vessel, for men to hold on by.

LIFT. A rope, or tackle, going from the yard-arms to the mast-head, to support and move the yard. Also a term applied to the sails when the wind strikes them on the leeches and raises them slightly.

LIGHT. To move or lift anything along; as, to "*Light* out to windward!" that is, haul the sail over to windward. The *light sails* are all above the topsails, also the studding sails and flying jib.

LIGHTER. A large boat, used in loading and unloading vessels.

LIMBERS, or LIMBER-HOLES. Holes cut in the lower part of the floor-timbers, next the keelson, forming a passage for the water fore-and-aft.

Limber-boards are placed over the limbers, and are movable.

Limber-rope. A rope rove fore-and-aft through the limbers, to clear them if necessary.

Limber-streak. The streak of foot-waling nearest the keelson.

LIST. The inclination of a vessel to one side; as, a *list* to port, or a *list* to starboard.

LISTING. A narrow strip taken off the edge of a plank to expose the ship's timbers for an examination.

LIZARD. A piece of rope, sometimes with two legs, and one or more iron thimbles spliced into it. It is used for various purposes. One with two legs, and a thimble to each, is often made fast to the topsail tye, for the buntlines to reeve through. A single one is sometimes used on the swinging-boom topping-lift.

LOCKER. A chest or box to stow anything away in.

Chain-locker. Where the chain cables are kept.

Boatswain's-locker. Where tools and small stuff for working upon rigging are kept.

LOG, or LOG-BOOK. A journal kept by the chief officer, in which the situation of the vessel, winds, weather, courses, distances, and every thing of importance that occurs, is noted down.

Log. A line with a piece of board, called the *log-ship*, attached to it, wound upon a reel, and used for ascertaining the ship's rate of sailing.

LONG-BOAT. The largest boat in a merchant-vessel. When at sea, it is carried between the fore and main masts.

LONGERS. The longest casks, stowed next the keelson.

LONG-TIMBERS. Timbers in the cant-bodies, reaching from the dead-wood to the head of the second futtock.

LOOF. That part of a vessel where the planks begin to bend as they approach the stern.

LOOM. That part of an oar which is within the row-lock. Also to appear above the surface of the water; to appear larger than nature, as in a fog.

LUBBER'S HOLE. A hole in the top, next the mast.

LUFF. To put the helm so as to bring the ship up nearer to the wind. *Spring-a-luff! Keep your luff!* &c., are orders to luff. Also the roundest part of a vessel's bow. Also the forward leech of fore-and-aft sails.

LUFF-TACKLE. A purchase composed of a double and single block.

Luff-upon-luff. A luff-tackle applied to the fall of another.

LUGGER. A small vessel carrying lug-sails.

Lug-sail. A sail used in boats and small vessels, bent to a yard which hangs obliquely to the mast.

LURCH. The sudden rolling of a vessel to one side.

LYING-TO. (See LIE-TO.)

MADE. A *made mast* or *block* is one composed of different pieces. A ship's lower mast is a made spar, her topmast is a whole spar.

MALL, or MAUL. (Pronounced *mawl.*) A heavy iron hammer used in driving bolts.

MALLET. A small maul, made of wood; as, *caulking-mallet*, also *serving-mallet*, used in putting service on a rope.

MANGER. A coaming just within the hawse-hole. Not much in use.

MAN-ROPES. Ropes used in going up and down a vessel's side.

MARL. To wind or twist a small line or rope round another.

MARLINE. (Pronounced *mar-lin.*) Small two-stranded stuff used for marling. A finer kind of spunyarn.

MARLING-HITCH. A kind of hitch used in marling.

MARLINGSPIKE. An iron pin, sharpened at one end, and having a hole in the other for a lanyard. Used both as a fid and a heaver.

MARRY. To join ropes together by a worming over both.

MARTINGALE. A short, perpendicular spar, under the bowsprit end, used for guying down the head-stays. (See DOLPHIN-STRIKER.)

MAST. A spar set upright from the deck, to support rigging, yards, and sails. Masts are whole or *made.*

MAT. Made of strands of old rope, and used to prevent chafing.

MATE. An officer under the master.

MAUL. (See MALL.)

MEND. *To mend service* is to add more to it.

MESHES. The places between the lines of a netting.

MESS. Any number of men who eat and lodge together.

MESSENGER. A rope used for heaving in a cable by the capstan.

MIDSHIPS. The timbers at the broadest part of the vessel. (See AMIDSHIPS.)

MISS-STAYS. To fail of going about from one tack to another.

MIZEN-MAST. The aftermost mast of a ship. The spanker is sometimes called the *mizen*.

MONKEY-BLOCK. A small single block strapped with a swivel.

MOON-SAIL. A small sail sometimes carried in light winds, above a skysail.

MOOR. To secure by two anchors.

MORTICE. A *morticed block* is one made out of a whole block of wood with a hole cut in it for the sheave; in distinction from a *made block*.

MOULDS. The patterns by which the frames of a vessel are worked out.

MOUSE. To put turns of rope-yarn or spun-yarn round the end of a hook and its standing part, when it is hooked to anything so as to prevent its slipping out.

MOUSING. A knot or puddening, made of yarns, and placed on the outside of a rope.

MUFFLE. Oars are muffled by putting mats or canvas round their looms in the row-locks.

MUNIONS. The pieces that separate the lights in the galleries.

NAVAL HOODS, or HAWSE BOLSTERS. Plank above and below the hawse-holes.

NEAP TIDES. Tides that occur two or three days after the moon has entered her second and fourth quarters. (See SPRING TIDES.)

NEAPED, or BENEAPED. The situation of a vessel when she is aground at the height of the spring tides.

NEAR. Close to the wind. "Near!" the order to the helmsman when he is too near the wind; caution to keep the sails full.

NETTING. Network of rope or small lines. Used for stowing away sails or hammocks.

NETTLES. (See KNITTLES.)

NINEPIN BLOCK. A block in the form of a ninepin, used for a *fair leader* in the rail.

NIP. A short turn in a rope.

NIPPERS. A number of yarns marled together, used to secure a cable to the messenger.

NOCK. The forward upper end of a sail that sets with a boom.

NORMAN. A square fid fixed through the rudder head, to prevent the loss of rudder should it get unshipped.

NORMANS. Stout pieces of iron placed in the holes of the windlass to prevent the chain fouling as it runs out.

NUN-BUOY. A buoy tapering at each end.

NUT. Projections on each side of the shank of an anchor, to secure the stock to its place.

OAKUM. Material made by picking rope-yarn to pieces; old rope untwisted and loosened like hemp. Used for caulking, and other purposes.

OAR. A long wooden instrument with a flat blade at one end, used for propelling boats.

OFF-AND-ON. To stand on different tacks towards and from the land.

OFFING. Distance from the shore.

OFF THE WIND. Not close to the wind.

ORLOP. The lower deck of a ship of the line; or, that on which the cables are stowed.

OUT-HAUL. A rope used for hauling out the clew of a boom sail.

OUTRIGGER. A spar rigged out to windward from the tops or cross-trees, to spread the breast-backstays.

OVERHAUL. *To overhaul a tackle* is to let go the fall and pull on the leading parts so as to separate the blocks.

To overhaul a rope is generally to pull a part through a block so as to make slack.

To overhaul rigging is to examine it.

OVER-RAKE. Said of heavy seas which come over a vessel's head when she is at anchor, head to the sea.

PAINTER. A rope attached to the bows of a boat, used for making her fast.

PALM. A piece of leather fitted over the hand, with an iron for the head of a needle to press against in sewing upon canvas. Also the fluke of an anchor.

PARBUCKLE. To hoist or lower a spar or cask by single ropes passed round it.

PARCEL. To wind tarred canvas (called *parcelling*) round a rope.

PARCELLING. (See PARCEL.)

PARLIAMENT-HEEL. The situation of a vessel when she is careened.

PARRAL. The rope by which a yard is confined to a mast at its centre.

PART. To break a rope.

PARTNERS. A framework of short timber fitted to the hole in a deck, to receive the heel of a mast or pump, &c. Woodwork for the support of anything passing through a ship's deck.

PAZAREE. A rope attached to the clew of the foresail and rove through a block on the swinging boom. Used for guying the clews out when before the wind.

PAUNCH MAT. A thick mat, placed at the slings of a yard or elsewhere.

PAWL, or PAUL. A short bar of iron, which prevents the capstan or windlass from turning back.

To pawl is to drop a pawl and secure the windlass or capstan.

PAY OFF. When a vessel's head falls off from the wind.

To pay. To cover over with tar or pitch.

To pay out. To slack up on a cable or rope, and let it run out.

PEAK. The upper outer corner of a gaff-sail.

PEAK. (See A-PEAK.)

A *stay-peak* is when the cable and forestay form a line.

A *short stay-peak* is when the cable is too much in to form this line.

PENDANT, or PENNANT. A long narrow piece of bunting, carried at the mast-head.

Pennant. A rope to which a purchase is hooked. A long strap fitted at one end to a yard or mast-head, with a hook or block at the other end, for a brace to reeve through, or to hook a tackle to.

PILLOW. A block which supports the inner end of the bowsprit.

PIN. The axis on which a sheave turns. Also a short piece of wood or iron to belay ropes to.

PINK-STERN. A high, narrow stern.

PINNACE. A boat, in size between the launch and cutter.

PINTLE. A metal bolt used for hanging a rudder.

PITCH. A resin taken from pine, and used for filling up the seams of a vessel.

PLANKS. Thick, strong boards, used for covering the sides and decks of vessels.

PLANK-SHEERS. Planks laid horizontally over the timber heads, covering the top of the side.

PLAT. A braid of foxes. (See FOX.)

PLATE. (See CHAIN-PLATE.)

PLUG. A piece of wood, fitted into a hole in a vessel or boat, so as to let in or keep out water.

POINT. To take the end of a rope and work it over with knittles. (See REEF-POINTS.) A division of the Mariner's Compass.

POLE. Applied to the highest mast of a ship, usually painted; as, *sky-sail pole.*

POOP. A deck raised over the after part of the spar deck. A vessel is *pooped* when the sea breaks over her stern.

POPPETS. Perpendicular pieces of timber fixed to the fore-and-aft part of the bilge-ways in launching.

PORT. Used instead of *larboard.*

Port side. The left side of the ship, when looking forward.

To port the helm is to put it to the port side of the ship.

PORT, or PORT-HOLE. Holes in the side, bow, or stern of a vessel, to admit air or cargo. (See BRIDLE.)

PORTOISE. The gunwale. The yards are *a-portoise* when they rest on the gunwale.

PORT-SILLS. (See SILLS.)
PORT-TACK. Having the port-tacks on board.
PREVENTER. An additional rope or spar, used as a support.
PRICK. A quantity of spun-yarn or rope laid close up together.
PRICKER. A small marlingspike, used in sail-making. It generally has a wooden handle.
PUDDENING. A quantity of yarns, matting, or oakum, used to prevent chafing.
PUMP. The machine fitted to draw the water out of the ship's hold.
PUMP-BRAKE. The handle to the pump.
PUMP-CHAMBER. The space in which the upper box of the pump works.
PUMP-SPEAR. The iron rod attached to the upper box of the pump.
PUMP-WELL. The space below the lower end of the pump.
PURCHASE. A mechanical power which increases the force applied. *To purchase* is to raise by a purchase.

QUARTER. The part of a vessel's side between the after part of the main chains and the stern. The *quarter* of a yard is between the slings and the yard-arm.
The wind is said to be *quartering* when it blows in a line between that of the keel and the beam, and abaft the latter.
QUARTER-BLOCK. A block fitted under the quarters of a yard on each side the slings, for the clewlines and sheets to reeve through.
QUARTER-DECK. That part of the upper deck abaft the main-mast.
QUARTER-MASTER. A petty officer in a man-of-war, who attends the helm and binnacle at sea; and watches for signals, &c., when in port.
QUICK-WORK. That part of a vessel's side which is above the chain-wales and decks. So called in ship-building.
QUILTING. A coating about a vessel, outside, formed of ropes woven together.
QUOIN. A wooden wedge.

RABBET. A groove in a piece of wood for the edge of another piece to fit in.
RACE. A strong rippling tide.
RACK. To seize two ropes together, with cross-turns. Also a *fair-leader* for running rigging.
RACK-BLOCK. A course of blocks made from one piece of wood, for fair leaders.
RAKE. The inclination of a mast from the perpendicular.
RAMLINE. A line used in mast-making to get a straight middle line on a spar.
RANGE OF CABLE. A quantity of cable, more or less, placed in order for letting go the anchor or paying out, to insure it reaching the bottom without checking.

RATLINES. (Pronounced *ratlins*.) Lines running across the shrouds, horizontally, like the rounds of a ladder, and used to step upon in going aloft.

RATTLE DOWN RIGGING. To put ratlines upon rigging. It is still called rattling *down*, though they are now rattled *up*, beginning at the lowest.

REEF. To reduce a sail by taking in upon its head, if a square sail, and its foot, if a fore-and-aft sail.

REEF-BAND. A band of stout canvas sewed on the sail across, with points in it, and earings at each end for reefing.

A *reef* is all of the sail that is comprehended between the head of the sail and the first reef-band, or between two reef-bands.

REEF-POINT. The cordage used to tie up a sail when reefing it.

REEF-TACKLE. A tackle used to haul the middle of each leech up towards the yard, so that the sail may be easily reefed.

REEVE. To pass the end of a rope through a block, or any aperture.

RELIEVING TACKLE. A tackle hooked to the tiller in a gale of wind, to steer by, in case anything should happen to the wheel or tiller-ropes.

RENDER. To pass a rope through a place. A rope is said to *render* or not, according as it goes freely through any place.

RIB-BANDS. Long, narrow, flexible pieces of timber nailed to the outside of the ribs, so as to encompass the vessel lengthwise.

RIBS. A figurative term for a vessel's timbers.

RIDE. To lie at anchor. Also to bear down by main strength and weight; as, to ride down the main tack. A rope *rides* when the strain part overlies the preceding turn.

RIDERS. Interior timbers placed occasionally opposite to the principal ones, to which they are bolted, reaching from the keelson to the beams of the lower deck. Also casks forming the second tier in a vessel's hold.

RIGGING. The general term for all the ropes of a vessel. (See RUNNING, STANDING.) Also the common term for the shrouds with their ratlines; as, *the main rigging, mizen rigging*, &c.

RIGHT. To *right* the helm is to put it amidships.

RIM. The edge of a top.

RING. The iron ring at the upper end of an anchor, to which the cable is bent.

RING-BOLT. An eye-bolt with a ring through the eye.

RING-TAIL. A small sail, shaped like a jib, set abaft the spanker in light winds.

ROACH. A curve in the foot of a square sail, by which the clews are brought below the middle of the foot. The *roach* of a fore-and-aft sail is in its forward leech.

ROAD, or ROADSTEAD. An anchorage at some distance from the shore.

ROBANDS. (See ROPE-BANDS.)

ROLLING-TACKLE. Tackles used to steady the yards in a heavy sea.

ROMBOWLINE. Condemned or old canvas, rope, &c. Twice laid rope, &c. A name given to the lashing round a new coil of rope.

ROPE-BANDS, or ROBANDS. Small pieces of two or three yarns, spun-yarn, or marline, used to confine the head of the sail to the yard or gaff.

ROPE-YARN. A thread of hemp, or other stuff, of which a rope is made.

ROUGH-TREE. An unfinished spar. Formerly the upper rail of bulwark.

ROUND IN. To haul in on a rope, especially a weather-brace.

ROUND UP. To haul up on a tackle.

ROUNDING. A service of rope, hove round a spar or larger rope.

ROWLOCKS, or ROLLOCKS. Places cut in the gunwale of a boat for the oars to rest in while pulling.

ROYAL. A light sail next above a topgallant sail.

ROYAL YARD. The yard from which the royal is set. The fourth from the deck.

RUBBER. A small instrument used to rub or flatten down the seams of a sail in sail-making.

RUDDER. The machine by which a vessel or boat is steered.

RUN. The narrowing of the ship abaft; the after part of a vessel's bottom, which rises and narrows in approaching the stern-post.

By the run. To let go *by the run* is to let go altogether, instead of slacking off.

RUNG-HEADS. The upper ends of the floor timbers.

RUNNER. A rope used to increase the power of a tackle. It is rove through a single block which you wish to bring down, and a tackle is hooked to each end, or to one end, the other being made fast.

RUNNING RIGGING. The ropes that reeve through blocks, and are pulled and hauled, such as braces, halyards, &c.; in opposition to the *standing rigging*, the ends of which are securely seized, such as stays, shrouds, &c.

SADDLES. Pieces of wood hollowed out to fit on the yards, to which they are nailed, having a hollow in the upper part for the boom to rest in.

SAG. To *sag to leeward* is to drift off bodily to leeward.

SAGGED. The middle part of the ship lower than the ends; the reverse of hogged.

SAILS. The surface of canvas spread on or between the masts to receive the force of the wind and press the vessel through the water: they are of two kinds—*square sails*, which hang from yards, their foot lying across the line of the keel, as the courses, topsails, &c.; and *fore-and-aft-sails*, which set upon gaffs, or on stays, their foot running with the line of the keel, as jib, spanker, &c.

SAIL HO! The cry used when a sail is first discovered at sea.

SALVAGE. Goods saved from wreck. An allowance to those by whose means a ship or goods are saved.

SAVE-ALL. A small sail sometimes set under the foot of a lower studding-sail. (See WATER SAIL.)

SCANTLING. A term applied to any piece of timber, with regard to its breadth and thickness, when reduced to the standard size.

SCARPH, or SCARF. To join two pieces of timber at their ends by shaving them down and placing them over-lapping.

SCHOONER. A small vessel with two masts and no tops.

A *fore-and-aft schooner* has only fore-and-aft sails.

A *topsail schooner* carries a square fore topsail, and frequently also topgallant sail and royal. There are some schooners with three masts. They also have no tops.

A *maintopsail schooner* carries square topsails, fore and aft.

SCORE. The groove in a block (or dead-eye) round which the rope passes.

SCOTCHMAN. A large batten placed over the turnings-in of rigging. (See BATTEN.)

SCRAPER. A small, triangular iron instrument, with a handle fitted to its centre, and used for scraping decks and masts.

SCROWL. A piece of timber bolted to the knees of the head, in place of a figure-head.

SCUD. To drive before a gale, with no sail, or only enough to keep the vessel ahead of the sea. Also low, thin clouds that fly swiftly before the wind.

SCULL. A short oar.

To scull is to impel a boat by one oar at the stern.

SCUPPERS. Holes cut in the water-ways for the water to run from the decks.

SCUTTLE. A hole cut into a vessel's deck, as a hatchway. Also a hole cut in any part of a vessel. (See BUTT.)

To scuttle is to cut or bore holes in a vessel to make her sink.

SEAMS. The intervals between planks in a vessel's deck or side.

SEIZE. To fasten ropes together by turns of small stuff.

SEIZINGS. The fastenings of ropes that are seized together.

SELVAGEE. A skein of rope-yards or spun-yarn, marled together. Used as a neat strap.

SEND. When a ship's head or stern pitches suddenly and violently into the trough of the sea.

SENNIT, or SINNIT. A braid, formed by plaiting rope-yarns or spun-yarn together. Straw, plaited for hats.

SERVE. To wind small stuff, as rope-yarns, spun-yarn, &c., round a rope to keep it from chafing. It is wound and hove round taut by a serving-board or mallet.

SERVICE is the stuff so wound round.

SET. To *set up rigging* is to tauten it by tackles. The seizings are then put on afresh.

SHACKLES. Links in a chain cable which are fitted with a movable bolt, so that the chain can be separated.

SHAKES. The staves of hogsheads taken apart.

SHAKING. The fluttering of a sail from the wind blowing in a line with the yard.

SHANK. The main piece in an anchor, at one end of which the stock is made fast, and at the other the arms.

SHANK-PAINTER. A strong rope by which the lower part of the shank of an anchor is secured to the ship's side. A piece of chain.

SHARP UP. Said of yards when braced as near fore-and-aft as possible.

SHEATHING. A casing or covering on a vessel's bottom.

SHEARS. Two or more spars, raised at angles and lashed together near their upper ends, used for taking in masts.

SHEAR HULK. An old vessel fitted with shears, &c., and used for taking out and putting in the masts of other vessels.

SHEAVE. The wheel in a block upon which the rope works.

Sheave-hole. The place cut in a block for the ropes to reeve through.

SHEEP-SHANK. A kind of hitch or bend, used to shorten a rope temporarily.

SHEER-POLE. A piece of iron across the rigging above the upper dead eyes, and seized to each shroud.

SHEER, or SHEER-STAKE. The line of plank on a vessel's side, running fore-and-aft under the gunwale. *Sheer* is also a vessel's position when riding by a single anchor.

SHEET. A rope used in setting a sail, to keep the clew down to its place. With square sails, the sheets run through each yard-arm. With boom sails, they haul the boom over one way and another. They keep down the inner clew of a studding sail, and the after clew of a jib. (See HOME.)

SHEET ANCHOR. A vessel's largest anchor: not carried at the bow.

SHELL. The case of a block.

SHINGLE. (See BALLAST.)

SHIP. A vessel with three masts, with tops and yards to each. To enter on board a vessel. To fix anything in its place.

SHIVER. To shake the wind out of a sail by bracing it so that the wind strikes upon the leech.

SHOE. A piece of wood used for the bill of an anchor to rest upon, to save the vessel's side. Also for the heels of shears, &c.

SHOE-BLOCK. A block with two sheaves, one above the other, the one horizontal and the other perpendicular.

SHORE. A prop or stanchion, placed under a beam. To *shore*, to prop up.

SHROUDS. A set of ropes reaching from the mast-heads to the vessel's sides, to support the masts.

SILLS. Pieces of timber put in horizontally between the frames to form and secure any opening; as, for ports.

SISTER BLOCK. A long piece of wood with two sheaves in it, one above the other, with a score between them for a seizing, and a groove around the block, lengthwise.

SKEG. The after part of the keel whereon the stern-post is fixed.

SKIDS. Pieces of timber placed up and down a vessel's side, to bear any articles off clear that are hoisted in.

SKIN. The part of a sail which is outside and covers the rest when it is furled. Also, familiarly, the sides of the hold; as, an article is said to be stowed *next the skin*.

SKYSAIL. A light sail next above the royal.

SKY-SCRAPER. A name given to a skysail when it is triangular.

SLABLINE. A small line used to haul up the foot of a course.

SLABS. Pieces of wood fitted between the whelps.

SLACK. The part of a rope or sail that hangs down loose. To loosen.

Slack in stays. Said of a vessel when she works slowly in tacking.

SLEEPERS. The knees that connect the transoms to the after timbers on the ship's quarters.

SLING. To set a cask, spar, gun, or other article, in ropes (slings), so as to put on a tackle and hoist or lower it.

SLINGS. The chain or rope used for suspending the centre of a yard to the mast. A rope with the two ends spliced together.

Yard-slings are now made of iron. Also a large rope fitted so as to go round any article which is to be hoisted or lowered.

SLIP. The distance the butts of one strake are from the butts of the strake above or below. To let go a cable and stand out to sea.

SLIP-ROPE. A rope bent to the cable just outside the hawse-hole and brought in on the weather quarter, for slipping.

SLOOP. A small vessel with one mast.

SLUE. To turn anything round or over.

SMALL HELM. Limited use of the helm.

SMALL STUFF. The term for spun-yarn, marline, and the smallest kinds of rope, such as ratline-stuff, &c.

SMART. Quick.

SNAKE. To pass small stuff across a seizing, with marling hitches at the outer turns.

SNATCH-BLOCK. A single block, with an opening in its side below the sheave, or at the bottom, to receive the bight of a rope.

SNOTTER. A rope going over a yard-arm, with an eye, used to bend a tripping line to in sending down topgallant and royal yards in vessels of war.

SNOW. A kind of brig.

SNUB. To check a rope suddenly. To bring a ship up suddenly with an anchor, and short range of cable, yet without jerking.

SNUG. Under proper sail to meet a gale.

SNYING. A term for a circular plank, edgewise, to work in the bows of a vessel.

So! An order to leave off hauling upon anything.

SOLE. A piece of timber fastened to the foot of the rudder, to make it level with the false keel.

SOUND. To get the depth of water by a lead and line. The pumps are *sounded* by an iron *sounding rod*, marked with a scale of feet and inches.

SPAN. A rope with both ends made fast, for a purchase to be hooked to its bight.

SPANKER. The after sail of a ship or bark. It is a fore-and-aft sail, setting with a boom and gaff.

SPAR. The general term for all masts, yards, booms, gaffs, &c.

SPELL. The common term for a portion of time given to any work.

To spell is to relieve another at his work.

Spell ho! An exclamation used as an order or request to be relieved at work by another.

SPENCER. A fore-and-aft sail, set with a gaff and no boom, and hoisting from a small mast called a *spencer mast*, just abaft the fore and main masts.

SPILL. To shake the wind out of a sail by bracing it so that the wind may strike its leech and shiver it.

SPILLING LINE. A rope used for spilling a sail; rove in bad weather.

SPINDLE. An iron pin upon which the capstan moves. Also a piece of timber forming the diameter of a made mast. Also any long pin or bar upon which anything revolves.

SPIRKETING. The planks from the water-ways to the port-sills.

SPLICE. To join two ropes together by interweaving their strands.

SPOKE. A handle of the wheel.

SPOON-DRIFT. Water swept from the tops of the waves by the violence of the wind in a tempest, and driven along before it, covering the surface of the sea.

SPRAY. An occasional sprinkling dashed from the top of a wave by the wind, or by its striking an object.

SPRING. To crack or split a mast.

To spring a leak is to begin to leak.

To spring a luff is to force a vessel close to the wind, in sailing.

SPRING-STAY. A preventer-stay, to assist the regular one. (See STAY.)

SPRING TIDES. The highest and lowest course of tides, occurring every new and full moon.

SPRIT. A small boom or gaff, used with some sails in small boats. The lower end rests in a becket or snotter by the foot of the mast, and the other end spreads and raises the outer upper corner of

the sail, crossing it diagonally. A sail so rigged is called a *sprit-sail.*

SPRIT-SAIL YARD. A yard lashed across the bowsprit or knight-heads, and used to spread the guys of the jib and flying jib-boom. There was formerly a sail bent to it called a *sprit-sail.*

SPRUNG. Damaged in various ways.

SPUN-YARN. A cord formed by twisting together two or three rope-yarns.

SPURLING-LINE. A line communicating between the tiller and tell-tale.

SPURS. Pieces of timber fixed on the bilge-ways, their upper ends being bolted to the vessel's sides above the water. Also curved pieces of timber, serving as half-beams, to support the decks where whole beams cannot be placed.

SPUR-SHOES. Large pieces of timber that come abaft the pump-well.

SQUARE. Yards are *squared* when they are horizontal and at right angles with the keel. Squaring by the lifts makes them horizontal; and by the braces, makes them at right angles with the vessel's line. Also the proper term for the length of yards. A vessel has square yards when her yards are unusually long. A sail is said to be very *square* in the head when it is long on the head.

To square a yard, in working a ship, means to bring it in square by the braces.

SQUARE-SAIL. A temporary sail set at the fore-mast of a schooner or sloop when going before the wind. (See SAIL.)

STABBER. A pricker.

STAFF. A pole or mast used to hoist flags upon.

STANCHIONS. Upright posts of wood or iron, placed so as to support the beams of a vessel. Also upright pieces of timber, placed at intervals along the sides of a vessel, to support the bulwarks and rail, and reaching down to the bends, by the side of the timbers, to which they are bolted. Also any fixed, upright support; as to an awning, or for the man-ropes.

STANDARD. An inverted knee, placed above the deck, instead of beneath it; as, *bitt-standard,* &c.

STAND BY! In order to be prepared.

STANDING. The *standing part* of a rope is that part which is fast, in opposition to the part that is hauled upon; or the main part, in opposition to the end.

The *standing part* of a tackle is that part which is made fast to the blocks, and between that and the next sheave, in opposition to the hauling and leading parts.

STANDING RIGGING. That part of a vessel's rigging which is made fast and not hauled upon. (See RUNNING.)

STARBOARD. The right side of a vessel, looking forward.

STARBOARD TACK. Having the starboard tack on board.

STARBOARD THE HELM. Putting the helm to starboard.

STARBOWLINES. The familiar term for the men in the starboard watch.

START. To *start a cask* is to open it.

STAY. To tack a vessel, or put her about, so that the wind, from being on one side, is brought upon the other, round the vessel's head. (See TACK, WEAR.)

To stay a mast is to incline it forward or aft, or to one side or the other, by the stays and backstays. Thus, a mast is said to be *stayed* too much forward or aft, or too much to port, &c.

STAYS. Large ropes, used to support masts, and leading from the head of some mast down to some other mast, or to some part of the vessel. Those which lead forward are called *fore-and-aft stays;* and those which lead down to the vessel's sides, *backstays.* (See BACKSTAYS.)

In stays, or *hove in stays.* The situation of a vessel when she is *staying* or going about from one tack to the other.

STAYSAIL. A sail which hoists upon a stay.

STEADY! An order to keep the helm as it is.

STEERAGE. That part of the between-decks which is just forward of the cabin.

STEERING. Guiding a ship on her course.

STEEVES. A bowsprit *steeves* more or less, according as it is raised more or less from the horizontal.

The *steeve* is the angle it makes with the horizon. Also a long heavy spar, with a place to fit a block at one end, and used in stowing certain kinds of cargo which need to be driven in close.

STEM. A piece of timber reaching from the forward end of the keel, to which it is scarphed, up to the bowsprit, and to which the two sides of the vessel are united.

STEMSON. A piece of compass timber, fixed on the after part of the apron inside. The lower end is scarphed into the keelson, and receives the scarph of the stem, through which it is bolted.

STEP. A block of wood secured to the keel, into which the heel of the mast is placed.

To step a mast is to put it in its step.

STERN. The after end of a vessel. (See BY THE STERN.)

STERN-BOARD. The motion of a vessel when going stern foremost.

STERN-FRAME. The frame composed of the stern-post transom and the fashion pieces.

STERN-POST. The aftermost timber in a ship, reaching from the after end of the keel to the deck. The stem and stern-post are the two extremes of a vessel's frame.

Inner stern-post. A post on the inside, corresponding to the *stern-post.*

STERN-SHEETS. The after part of a boat, abaft the rowers, where the passengers sit.

STIFF. The quality of a vessel, which enables it to carry a great deal of sail without lying over much on her side. The opposite to *crank*.

STIRRUPS. Ropes with thimbles at their ends, through which the foot-ropes are rove, and by which they are kept up towards the yards.

STOCK. A beam of wood, or a bar of iron, secured to the upper end of the shank of an anchor, at right angles with the arms. An iron stock usually goes with the key, and unships.

STOCKS. The frame upon which a vessel is built.

STOOLS. Small channels for the dead eyes of the backstays.

STOPPER. A stout rope with a knot at one end, and sometimes a hook at the other, used for various purposes about decks; as, making fast a cable, so as to overhaul. (See CAT STOPPER; DECK STOPPER.)

STOPPER-BOLTS. Ring-bolts to which the deck stoppers are secured.

STOP. A fastening of small stuff. Also small projections on the outside of the cheeks of a lower mast, at the upper parts of the hounds.

STOPWATER. A trenail driven through the stem and keel at their joining; also through the joining of the stern post and keel.

STRAND. A number of rope-yarns twisted together. Three, four, or nine strands, twisted together, form a rope.

A rope is *stranded* when one of its strands is parted or broken by chafing, or by a strain.

A vessel is *stranded* when she is driven on shore.

STRAP, or STROP. A piece of rope spliced round a block to keep its parts well together. Some blocks have iron straps, in which case they are called *iron-bound*.

STREAK, or STRAKE. One breadth of plank running entirely fore and aft, within or without.

STREAM. The *stream anchor* is one used for warping, &c., and sometimes as a lighter anchor to moor by, with a hawser. It is smaller than the *bowers*, and larger than the *kedges*.

To stream a buoy is to drop it into the water.

STRETCHERS. Pieces of wood placed across a boat's bottom, inside, for the oarsmen to place their feet against in rowing. Also cross pieces placed between a boat's sides to keep them apart when hoisted up and griped.

STRIKE. To lower a sail or colours.

STRINGERS. Strakes of plank round the inside of a vessel close to the under sides of the beams.

STUDDING-SAILS. Light sails set outside the square sails on booms rigged out for that purpose. They are only carried with a fair wind and in moderate weather.

SUED, or SEWED. The condition of a ship when high and dry on shore. If the water leaves her two feet, she *sues* or is *sued* two feet.

SUPPORTERS. The knee-timbers under the cat-heads.

SURF. The breaking of the sea upon the shore.

SURGE. A large swelling wave.

To surge a rope or cable is to slack it up suddenly where it renders round a pin, or round the windlass or capstan.

Surge ho! The notice given when a cable is to be *surged*.

SWAB. A mop, formed of old rope, used for cleaning and drying decks.

SWALLOW. The space in a block that takes the rope.

SWEEP. To drag the bottom for an anchor. Also large oars, used in small vessels to force them ahead.

SWIFT. To bring two shrouds or stays close together by ropes.

SWIFTER. The forward shroud to a lower mast. Also ropes used to confine the capstan bars to their places when shipped.

SWIG. A term used by sailors for the mode of hauling off upon the bight of a rope when its lower end is fast.

SWIVEL. A long link of iron, used in chain cables, made so as to turn upon an axis, and keep the turns out of a chain.

SYPHERING. Lapping the edges of planks over each other for a bulk-head.

TABLING. Letting one beam-piece into another. (See SCARPHING.) Also the broad hem on the borders of sails to which the bolt-rope is sewed.

TACK. To put a ship about, so that from having the wind on one side, you bring it round on the other, by the way of her head. The opposite of *wearing*.

A vessel is on the *starboard tack*, or has her *starboard tacks on board*, when she has the wind on her starboard side.

The rope or tackle by which the weather clew of a course is hauled forward and down to the deck.

The *tack* of a fore-and-aft sail is the rope that keeps down the lower forward clew; and of a studding-sail, the lower outer clew. The tack of the lower studding-sail is called the *out-haul*. Also that part of a sail to which the tack is attached.

TACKLE. (Pronounced *tay-cle*.) A purchase formed by a rope rove through one or more blocks.

TAFFRAIL, or TAFFEREL. The rail round a ship's stern.

TAIL. A rope spliced into the end of a block, and used for making it fast to rigging or spars. Such a block is called a *tail-block*.

A ship is said to *tail* up or down stream, when at anchor, according as her stern swings up or down with the tide; in opposition to *heading* one way or another, which is said of a vessel when under way.

TAIL-TACKLE. A watch tackle.

TAIL-ON! or TALLY ON! An order given to take hold of a rope and pull.

TANK. An iron vessel placed in the hold to contain the vessel's water.

TAR. A liquid gum, taken from pine and fir trees, and used for caulking, and to put upon yarns in rope-making, and upon standing rigging, to protect it from the weather.

TARPAULIN. A piece of canvas, covered with tar, used for covering hatches, boats, &c. Also the name commonly given to a sailor's hat, when made of tarred or painted cloth.

TAUNT. High or tall. Commonly applied to a vessel's masts.

All-a-taunt-o. Said of a vessel when she has all her light and tall masts and spars aloft.

TAUT. Tight.

TELL-TALE. A compass hanging from the beams of the cabin, by which the heading of a vessel may be known at any time. Also an instrument connected with the barrel of the wheel, and traversing so that the officer may see the position of the tiller.

TEND. To watch a vessel at anchor at the turn of tides, and cast her by the helm, and some sail if necessary, so as to keep turns out of her cables, and from fouling her anchor.

TENON. The heel of a mast, made to fit into the step.

THICK-AND-THIN BLOCK. A block having one sheave larger than the other. Sometimes used for quarter-blocks.

THIMBLE. An iron ring, having its rim concave on the outside for a rope or strap to fit snugly round.

THOLE-PINS. Pins in the gunwale of a boat, between which an oar rests when pulling, instead of a rowlock.

THOROUGH-FOOT. When parts of a fall cross each other; by turning one of the blocks the thorough-foot is taken out.

THROAT. The inner end of a gaff, where it widens and hollows in to fit the mast. (See JAWS.) Also the hollow part of a knee.

The *throat* brails, halyards, &c., are those that hoist or haul up the gaff or sail near the throat. Also the angle where the arm of an anchor is joined to the shank.

THROUGH-BOLT. Any bolt that goes quite through the timbers and planks of a vessel.

THRUM. To stick short strands of yarn through a mat or piece of canvas, to make a rough surface.

THWARTS. The seats going across a boat, upon which the oarsmen sit.

THWARTSHIPS. (See ATHWART-SHIPS.)

TIDE. To *tide up or down* a river or harbour is to work up or down with a fair tide and head wind or calm, coming to anchor when tide turns.

TIDE-RODE. The situation of a vessel, at anchor, when she swings by the force of the tide. In opposition to *wind-rode*.

TIER. A range of casks. Also the range of the fakes of a cable or hawser.

The *cable tier* is the place, in a hold or between decks, where the cables are stowed.

TILLER. A bar of wood or iron, put into the head of the rudder, by which the rudder is moved.

TILLER-ROPES. Ropes leading from the tiller-head round the barrel of the wheel by which a vessel is steered.

TIMBER. A general term for all large pieces of wood used in ship-building. Also, more particularly, long pieces of wood in a curved form, bending outward, and running from the keel up, on each side, forming the *ribs* of a vessel. The keel, stem, sternposts, and timbers form a vessel's outer frame.

TIMBER-HEADS. The ends of the timbers that come above the decks. Used for belaying hawsers and large ropes.

TIMENOGUY. A rope carried taut between different parts of the vessel, to prevent the sheet or tact of a course from getting foul in working ship.

TOGGLE. A pin placed through the bight or eye of a rope, block-strap, or bolt, to keep it in its place, or to put the bight or eye of another rope upon, and thus to secure them both together.

TOMPION. A bung or plug placed in the mouth of a cannon.

TOP. A platform placed over the head of a lower mast, resting on the trestle-trees, to spread the rigging, and for the convenience of men aloft.

To top up a yard or boom is to raise up one end of it by hoisting on the lift.

TOP-BLOCK. A large iron-bound block, hooked into a bolt under the lower cap, and used for the top-rope to reeve through in sending up and down topmasts.

TOP-LIGHT. A signal-lantern carried in the top.

TOP-LINING. A lining on the after part of sails, to prevent them from chafing against the top-rim.

TOPMAST. The second mast above the deck. Next above the lower mast.

TOPGALLANT-MAST. The third mast above the deck.

TOP-ROPE. The rope used for sending topmasts up and down.

TOPSAIL. The second sail above the deck.

TOPGALLANTSAIL. The third sail above the deck.

TOPPINGLIFT. A lift used for topping up the end of a boom.

TOP-TIMBERS. The highest timbers on a vessel's side, being above the futtocks.

TOSS. To throw an oar out of the rowlock, and raise it perpendicularly on its end, and lay it down in the boat, with its blade forward.

TOUCH. A sail is said to *touch* when the wind strikes the leech so as to shake it a little.

Luff and touch her! The order to bring the vessel up and see how near she will go to the wind.

TOW. To draw a vessel along by means of a rope.

TRAIN-TACKLE. The tackle used for running guns in and out.

TRANSOMS. Pieces of timber going across the sternpost, to which they are bolted.

TRANSOM-KNEES. Knees bolted to the transoms and after timbers.

TRAVELLER. An iron ring, fitted so as to slip up and down a rope or boom.

TREENAILS, or TRUNNELS. Long, cylindrical, hard, wooden pins, used for nailing a plank to a timber.

TREND. The lower end of the shank of an anchor, being the same distance on the shank from the throat that the arm measures from the throat to the bill.

TRESTLE-TREES. Two strong pieces of timber, placed horizontally and fore-and-aft on opposite sides of a mast-head, to support the cross-trees and top, and for the fid of the mast above to rest upon.

TRIATIC STAY. A rope secured at each end to the heads of the fore and main masts, with thimbles spliced into its bight, to hook the stay tackles to.

TRICE. To haul up by means of a rope.

TRICK. The time allotted to a man to stand at the helm.

TRIM. The condition of a vessel, with reference to her cargo and ballast. A vessel is *trimmed* by the head or by the stern.

In ballast trim is when she has only ballast on board.

Also to arrange the sails by the braces with reference to the wind.

TRIP. To raise an anchor clear of the bottom.

TRIPPING-LINE. A line used for tripping a topgallant or royal yard in sending it down.

TRUCK. A circular piece of wood, placed at the head of the highest mast on a ship. It has small holes or sheaves in it for signal halyards to be rove through. Also the wheel of a gun-carriage.

TRUNNIONS. The arms on each side of a cannon by which it rests upon the carriage, and on which it is elevated or depressed.

TRUSS. The rope by which the centre of a lower yard is kept in towards the mast.

TRYSAIL. A fore-and-aft sail, set with a boom and gaff, and hoisting on a small mast abaft the lower mast, called a *trysail-mast*. This name is generally confined to the sail so carried at the mainmast of a full-rigged brig; those carried at the foremost and at the mainmast of a ship or bark being called *spencers*, and those that are at the mizenmast of a ship or bark, *spankers*.

A vessel for towing other vessels.

TUMBLING HOME. Said of a ship's sides when they fall in above the bends. The opposite of *wall-sided*.

TURN. Passing a rope once or twice round a pin or kevel, to keep it fast. Also two crosses in a cable.

To turn in or *turn out*. Nautical terms for going to rest in a berth or hammock, and getting up from it.

Turn up! The order given to send the men up from between decks. *Turn to* is to commence work.

TYE. A rope connected with a yard, to the other end of which a tackle is attached for hoisting.

UNBEND. To cast off, let go, or untie. (See BEND.)

UNION. The upper inner corner of an ensign. The rest of the flag is called the *fly*.

Union down. The situation of a flag when it is hoisted upside down, bringing the union down instead of up. Used as a signal of distress.

Union-jack. A small flag, containing only the union without the fly, usually hoisted at the bowsprit-cap.

UNMOOR. To heave up one anchor so that the vessel may ride at a single anchor. (See MOOR.)

UNSHIP. Removing a thing from its place.

UVROU. (See EUVROW.)

VANE. A fly worn at the masthead, made of feathers or buntine, traversing on a spindle, to show the direction of the wind. (See DOG VANE.)

VANG. A rope leading from the peak of the gaff of a fore-and-aft sail to the rail on each side, and used for steadying the gaff.

'VAST. (See AVAST.)

VEER. Said of the wind when it changes. Also to slack a cable and let it run out.

To veer and haul is to haul and slack alternately on a rope, as in warping, until the vessel or boat gets headway.

VIOL, or VOYAL. A large messenger sometimes used in weighing an anchor by a capstan. Also the block through which the messenger passes.

WAIST. That part of the upper deck between the quarter-deck and forecastle.

Waisters. Green hands, or broken-down seamen, stationed to work in the waist of a vessel.

WAKE. The track or path a ship leaves behind her in the water.

WALES. Strong planks in a vessel's side running her whole length fore and aft.

WALL. A knot put on the end of a rope.

WALL-SIDED. A vessel is *wall-sided* when her sides run up perpendicularly from the bends. In opposition to *tumbling home* or *flaring out*.

WARD ROOM. The room in a vessel of war in which the commissioned officers live.

WARE, or WEAR. To turn a vessel round, so that from having the wind on one side, you bring it upon the other, carrying her stern round by the wind. In *tacking*, the same result is produced by carrying a vessel's head round by the wind.

WARP. To move a vessel from one place to another by means of a rope made fast to some fixed object, or to a kedge.

A *warp* is a rope used for warping. If the warp is bent to a kedge which is let go, and the vessel is hove ahead by the capstan or windlass, it would be called *kedging*.

WASH-BOARDS. Light pieces of board placed above the gunwale of a small vessel or boat.

WATCH. A division of time on board ship. There are seven watches in a day, reckoning through the 24 hours, five of them being of four hours each, and the two others, called *dog-watches*, of two hours each, viz. from 4 to 6, and from 6 to 8 P.M. (See DOG WATCH.) Also a certain portion of a ship's company, appointed to stand a given length of time. In the merchant service all hands are divided into two watches, larboard and starboard, with a mate to command each.

A *buoy* is said to *watch* when it floats on the surface.

WATCH-AND-WATCH. The arrangement by which the watches are alternated every other four hours. In distinction from keeping all hands during one or more watches.

Anchor watch. A small watch of one or two men, kept while in port.

WATCH-HO! WATCH! The cry of the man that heaves the deep-sea lead.

WATCH-TACKLE. A small luff-purchase with a short fall, the double block having a tail to it, and the single one a hook. Used for various purposes about decks.

WATER-SAIL. A *save-all*, set under the swinging-boom.

WATER-WAYS. Long pieces of timber, running fore and aft on both sides, connecting the deck with the vessel's sides. The *scuppers* are made through them to let the water off.

WEAR. (See WARE.)

WEATHER. In the direction from which the wind blows. (See WINDWARD, LEE.)

A ship carries a *weather-helm* when she tends to come up into the wind, requiring you to put the helm up.

Weather gage. A vessel has the *weather gage* of another when she is to windward of her.

Weatherly ship is one that works well to windward, making but little leeway.

WEATHER-BITT. To take an additional turn with a cable round the windlass-end.

WEATHER-ROLL. The roll which a ship makes to windward.

WEIGH. To lift up; as, to weigh an anchor or a mast.

WHEEL. The instrument by which a ship is steered; being a barrel (round which the tiller ropes go), and a wheel with spokes.

WHELPS. Pieces of iron to keep the chain cable from cutting the windlass.

WHIP. A purchase formed by a rope rove through a single block.

To whip is to hoist by a whip. Also to secure the end of a rope from fagging by a seizing of twine.

Whip-upon-whip. One whip applied to the fall of another.

WINCH. A purchase formed by a horizontal spindle or shaft with a wheel or crank at the end. A small one with a wheel is used for making ropes or spun-yarn.

WINDLASS. The machine used in merchant vessels to weigh the anchor by.

WIND-RODE. The situation of a vessel at anchor when she swings and rides by the force of the wind, instead of the tide or current. (See TIDE-RODE.)

WING. That part of the hold or between-decks which is next the side.

WINGERS. Casks stowed in the wings of a vessel.

WING-AND-WING. The situation of a fore-and-aft vessel when she is going dead before the wind, with her foresail hauled over on one side, and her mainsail on the other.

WITHE, or WYTHE. An iron instrument fitted on the end of a boom or mast, with a ring to it, through which another boom or mast is rigged out and secured, as a cap.

WOODLOCK. A piece of wood bolted to the rudder beneath one of the pintles, to prevent the rudder unshipping.

WOOLD. To wind a piece of rope round a spar.

WORK-UP. To draw the yarns from old rigging and make them into spun-yarn, foxes, sennit, &c. Also a phrase for keeping a crew constantly at work upon needless matters, and in all weathers, and beyond their usual hours, for punishment.

WORM. To fill up between the lays of a rope with small stuff wound round spirally. Stuff so wound round is called *worming*.

WRAIN-BOLTS. Bolts that secure the planks to the timbers.

WRAIN-STAVES. Strong pieces of plank used with the wrain-bolts.

WRING. To bend or strain a mast by setting the shrouds up too taut.

YACHT. (Pronounced *yot.*) A vessel of pleasure or state.

YARD. A long piece of timber, tapering slightly towards the ends, and hung by the centre to a mast, to spread the square sails r

YARD A-BOX is the sail attached to the yard being aback to act on the vessel's head, turning it away from the wind.

YARD-ARM. The extremities of a yard.

YARD-ARM AND YARD-ARM. The situation of two vessels, lying alongside one another, so near that their yard-arms cross or touch.

YARN. (See ROPEYARN.)

YAW. The motion of a vessel when, from bad steering, she goes off from her course.

YAWL. A cutter; a small fishing vessel.

YEOMAN. A man employed in a vessel to take charge of a storeroom; as, boatswain's yeoman, the man that has charge of the stores of rigging, &c.

YOKE. A piece of wood placed across the head of a boat's rudder, with a rope (*yoke-line*) attached to each end, by which the boat is steered.

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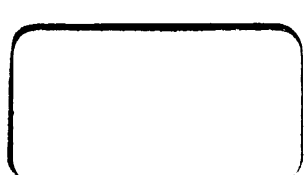
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